AGRICULTURAL ENGINEERING

FEBRUARY • 1953

In this Issue . . .

ASAE

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

New CASE Educational Movie

Here it is—hot out of the camera—the newest of a long line of Case educational movies, all 16 mm., in full color and sound. Young, pretty Betty learns modern fruit culture as she visits orchards and groves in the four corners of the nation and makes a side trip into Canada. This colorful, audience-holding film covers both vine and tree fruits, and is spiced with varied scenic shots. Instructive and entertaining to young and old alike, interesting to farm and city folk, valuable to farmers everywhere whatever their specialties.

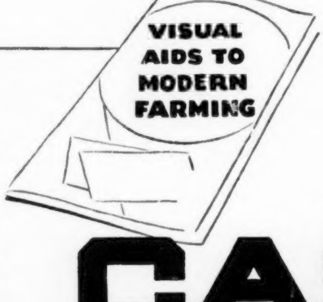
Teachers, county agents, farm and civic club leaders—all those engaged in disseminating technical and cultural information will find this film adaptable to a classroom hour or a full evening's program. Non-commercial. Runs 22 minutes.

"HIGH-CLEARANCE POWER" is another new film portraying the special applications of high-clearance tractors to tall, bushy, and bedded crops. Of special interest to farm families in truck-crop areas, this film is culturally broadening to viewers everywhere.

"YOU BE THE JUDGE" describes points to be considered in selecting a farm tractor. Runs 20 minutes. This and "High-Clearance Power" are built around the Case "VA" Series Tractors but apply to farm tractors generally. These Case educational motion pictures are readily fitted to a wide range of classroom and educational program uses.

60 Teaching Aids

Contributing to agricultural education, Case has prepared some sixty aids—movies (all 16 mm., in color and sound), slide films, booklets, posters, and other teaching aids. These cover subjects from terracing and water spreading to mower adjustment and safety. Films are loaned and printed matter is furnished without charge to teachers, county agents, farm and civic clubs, other responsible persons and groups. Be sure to ask your nearest Case dealer or branch house for a copy of the catalog, "Visual Aids to Modern Farming," which describes each item and tells how to order. J. I. Case Co., Racine, Wisconsin.



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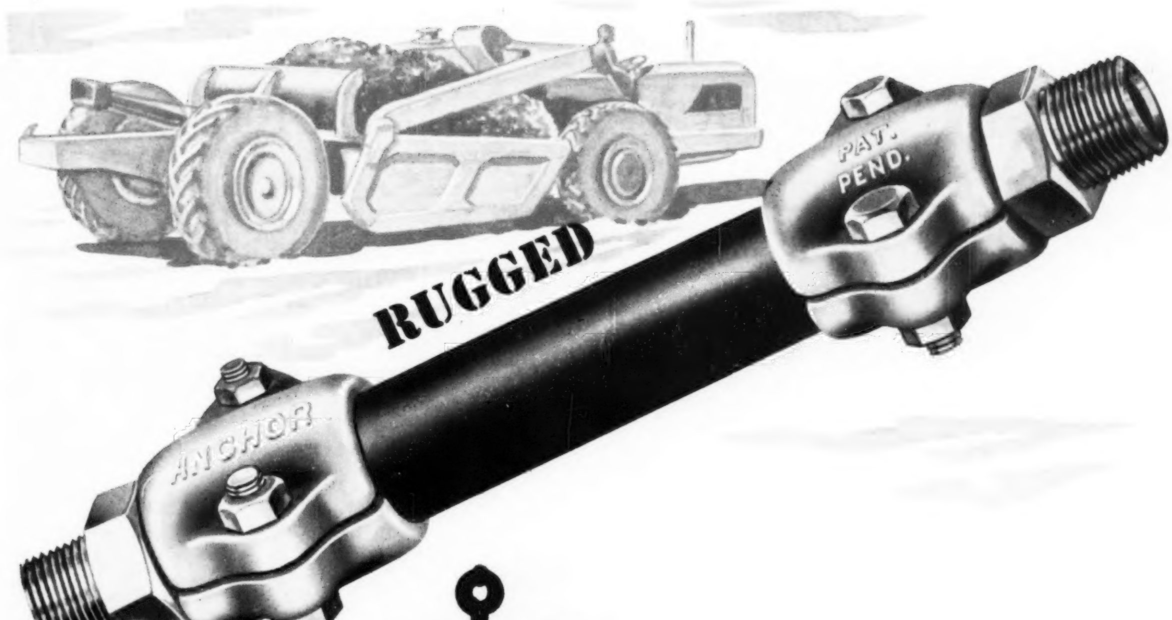

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AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR FEBRUARY, 1953

Vol. 34, No. 2

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INDEX TO ADVERTISERS

TO OUR READERS: Advertisers in this issue present their products and services for your scrutiny, with confidence in their engineering merit and capacity to meet the requirements for which intended, and with confidence in your appreciation of these contributions to engineering progress in agriculture.

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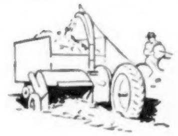

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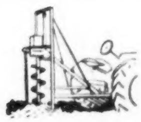

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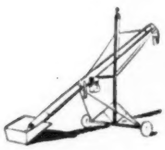

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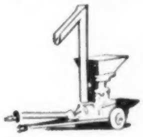

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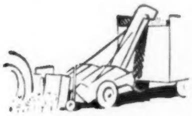

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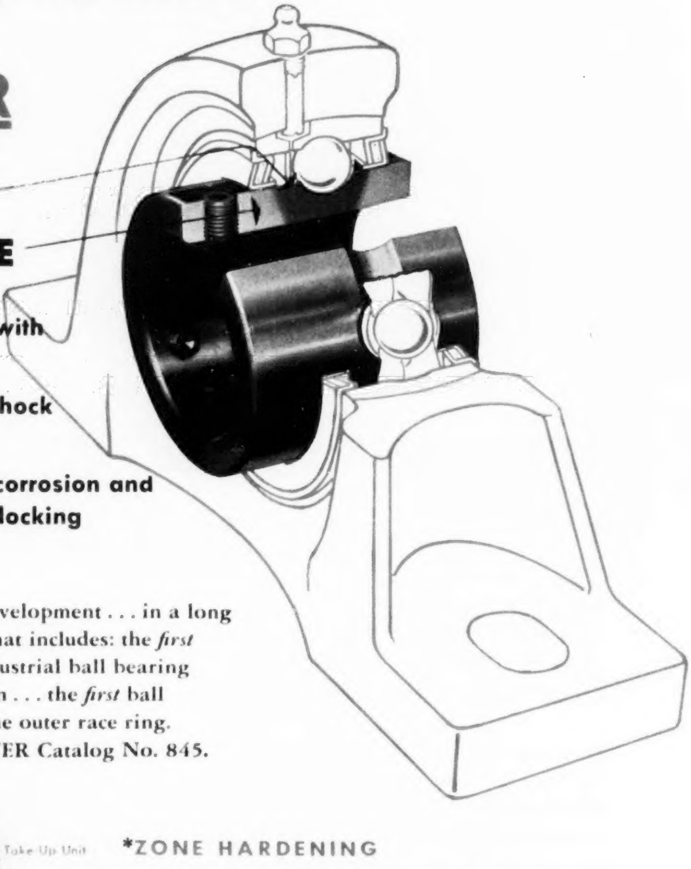

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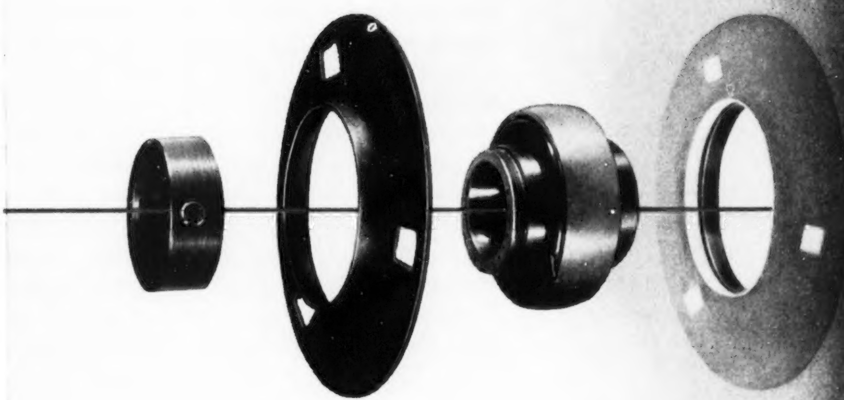
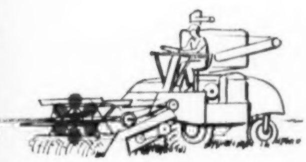




The Fafnir Flangette . . . *a pre-lubricated, completely-packaged ball bearing.*

This low-cost, easy-to-install ball bearing unit paved the way for important improvements in the design and construction of farm machinery and equipment. It cuts through cost barriers. It simplifies machinery construction. It improves overall performance. As a result, the advantages of ball bearings are available on more turning points today than ever before.

The Fafnir Flangette consists of a compact, lightweight housing of two, mated, pressed-steel flanges which can be bolted to almost any part of a machine . . . the famous Fafnir Wide Inner Ring Ball Bearing with Self-Locking Collar, easiest of all to install . . . efficient seals, which keep lubricant in and contaminants out. Flange design permits full self-alignment when installing.

This popular development reflects the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the manufacturer's viewpoint . . . an aptitude for supplying the right bearing to fit the need. Maybe this combination can help you find a better, more economical way to use ball bearings. The Fafnir Bearing Company, New Britain, Connecticut.

How you can *prevent* traction drive belt slippage under tough rice harvest conditions

International Harvester finds the Double Cog-Belt helps provide efficient, positive speed control.

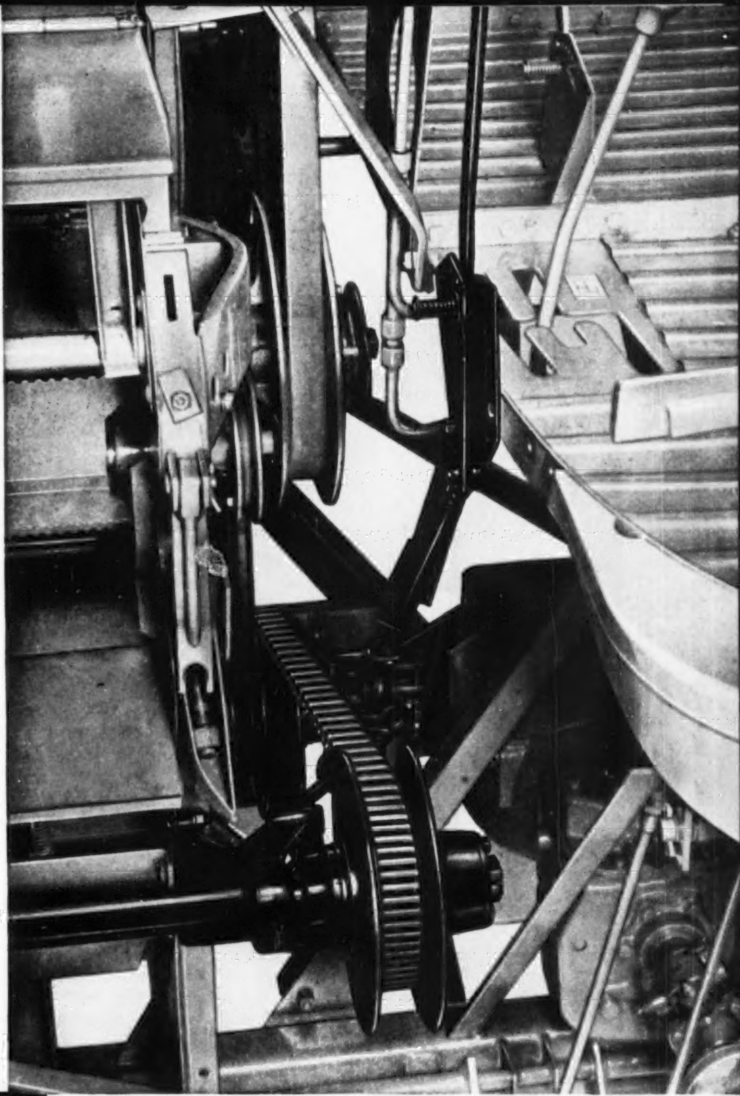
Mud, water standing in the fields, down grain—they're terrible harvesting conditions. But they are *routine* field conditions in the rice harvest, and self-propelled harvester-threshers must be prepared to take them in their stride. That's why International Harvester makes its "Rice Special" McCormick No. 127-SP to cope with tough rice field conditions.

Special rice type tires are fitted, and a crawler type track attachment is available for unusually severe conditions. But non-slip traction *at the ground* is not enough if the belt on the variable speed traction drive slips. And belts running in the sloppy rice fields have not only presented a bad slippage problem in the past, but the belts often had short lives.

International Harvester has solved that problem with Dayton Double Cog-Belts* on the variable speed traction drive. This variable speed unit, operating with a heavy-duty 4-speed transmission and clutch, gives the operator a choice of 28 different speeds. It permits speed changes without shifting

*T.M.

Photos courtesy International Harvester

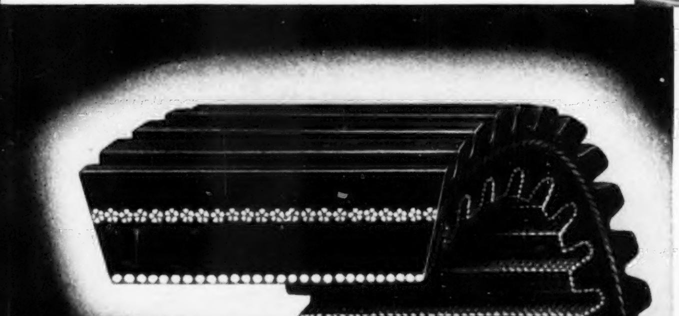


This is the convenient variable-speed drive on the McCormick self-propelled harvester-thresher. The Dayton Double Cog-Belt transmits power from the main drive jackshaft to the transmission gear case. The easy-to-reach lever changes the diameters of the two variable speed sheaves, providing seven speeds in each gear ratio. The Double Cog-Belt drive is located ahead of the clutch, so that it is constantly running and always able to deliver maximum power when needed.

gears or throttling the engine. The operator can match field travel speed to different ground and crop conditions quickly and easily. And with the reliable Dayton Double Cog-Belt, slippage is no longer a problem, even when inching over levees, or during other hard pulls.

For information on how the Double Cog-Belt's exclusive design provides more accurate speed control, longer belt life, cooler running, and greater load capacity, call or write The Dayton Rubber Company, Agricultural Original Equipment Division, 1009 W. Washington Blvd., Chicago, Illinois.

Photos Courtesy International Harvester



This is the closest approach yet made to the theoretically perfect belt for variable speed drives. It has great transverse rigidity, thanks to the molded cogs at top and bottom, and to the Stiflex fibers in the rubber compound. The belt's neutral axis is as thin as possible, to offer very little resistance to bending. Its light weight reduces centrifugal forces, and its Double-Cog design means fewer internal stresses, and greater radiant surface to dissipate heat.

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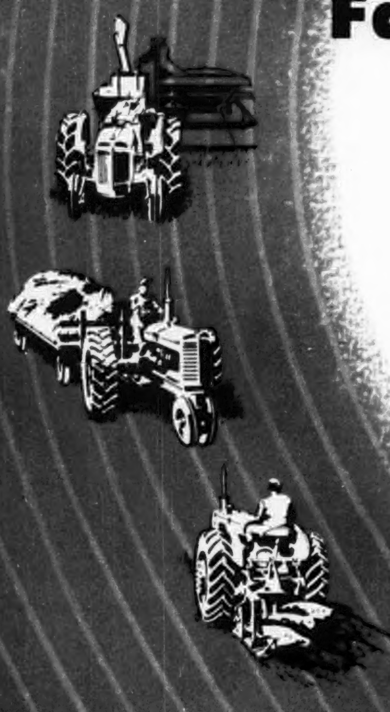

Automobile manufacturers, as well as truck and bus builders, have long recognized Bendix as braking headquarters for their industries. And today progressive tractor manufacturers are turning in increasing numbers to Bendix for the best solution to their individual braking problems.

There is good reason for this growing preference for Bendix Tractor Brakes. Nowhere else can be found comparable manufacturing facilities combined with an engineering experience that cover every major braking development in the past quarter of a century.*

Why not let Bendix farm tractor brake engineers help you find the best solution to your braking problems.

Your inquiry will receive prompt attention. Write for complete information.

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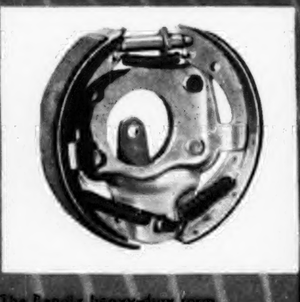

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1FR Series	1,080	"
L14S Series	1,230	"
3DR Series	1,800	"
L16S Series	2,200	"
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50N	20,000	"
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70N	57,000	"
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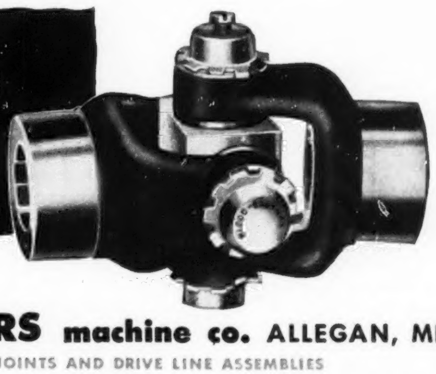

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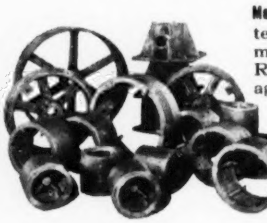

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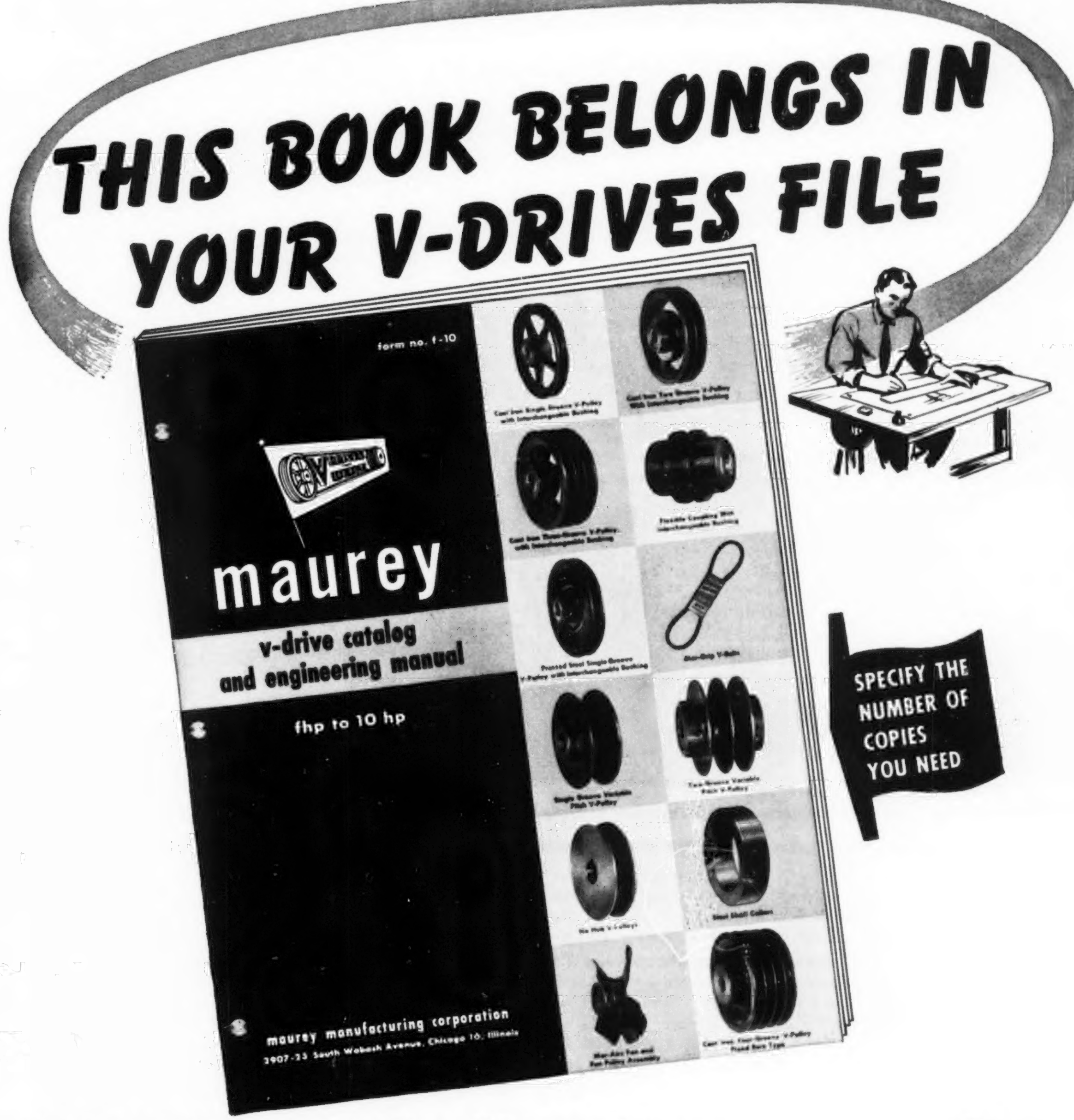

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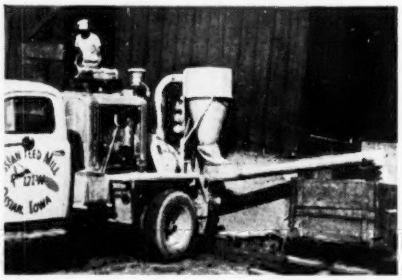
"**We use about 20 gallons** of fuel oil in our tractor a day instead of 40 gallons of gasoline," says Otho Snyder of Underwood, N. D. Snyder and Sons Farm repowered their tractor with a GM Diesel in 1950 and figure their fuel bill has dropped more than 60%. "We can make five rounds in the time it took to make four before, and the engine always has enough reserve power to go through potholes without getting stuck or stalling."

"**We ran this engine 39 days straight,** day and night, last summer during the dry spell," reports B. V. Conrardy of Marienthal, Kansas, who uses a 3-cylinder GM Diesel to drive an irrigation pump. Mr. Conrardy says the engine has been working six months a year since 1947 and hasn't cost him a dollar for repairs. After seeing the simplicity and economy of the engine, he installed a GM Diesel in a 5-plow tractor in 1948 and also repowered a 3-plow tractor in 1950.

"It used to take 38 minutes to grind 100 bushels of wheat. Now it takes only 27 because this engine doesn't slow up under sudden load increases," says John Jaster, who replaced the gasoline engine on his portable feed mill with a GM Diesel. He can grind 30% more feed per day, and that means a lot more jobs. The 65 H.P. Diesel burns about 3½ gallons of fuel per hour. "Compared with my gas engine, this Diesel is doing 30% more work and costing 65% less to run."



Farmers all across the country are switching to General Motors Diesel power because it gets more work done faster—at lower cost. This rugged 2-cycle Diesel uses safer, lower-cost fuel. It does both heavy and light jobs with the same economy, because it burns fuel in direct proportion to the work it does.

The GM Diesel is simple to operate and maintain. It starts at the push of a button. It's built for years of continuous hard work. To find out how much Diesel power can save you, see your GM Diesel distributor or write us for illustrated booklet, "For the Business Man on the Farm."

GM
GENERAL MOTORS
DIESEL POWER

DETROIT DIESEL
ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN

Single Engine . . . 16 to 275 H.P. Multiple Units . . . Up to 840 H.P.

THE WORLD-FAMOUS AETNA T-TYPE CLUTCH RELEASE BEARING

Plus VALUE FEATURES

• T-shaped oil-impregnated bronze ball separator maintains perfect concentricity—eliminates eccentric thrust, excessive wear—assures the plus smoothness, quietness and endurance of bronze-to-steel contact.

• Large, factory-packed grease reservoir assures lifetime lubrication—no need for costly grease fittings or oil lines.

• Special construction locks shell to free race, forming leak-proof joint. Lubricant can't escape to clutch facings, never needs replenishment.

• Case hardened races for wear-resistant working surface and tough, elastic, shock-absorbing core.

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts.

In 1953, as in the past 19 years more of the nation's mobile vehicles will be equipped with the Aetna T-Type clutch release bearing than with any other type. Its unrivaled service life has always made it the most economical in the long run. Once installed it is trouble-free, attention-free for vehicle life. Thanks to its design and lubricant capacity there's no need of costly machining operations for oil lines or grease fittings—no need for further maintenance whatsoever. Think what that saves in man and machine hours on the assembly line, in saving up-keep costs for the vehicle owner.

It's a trusty sign of dependability and economical performance in any vehicle—the famous Aetna T-Type bearing. Investigate. Find out the many other sound reasons it deserves a place in your specifications.

AETNA BALL AND ROLLER BEARING COMPANY
4600 Schubert Avenue • Chicago 39, Illinois

Why leading diesel engine builders say—

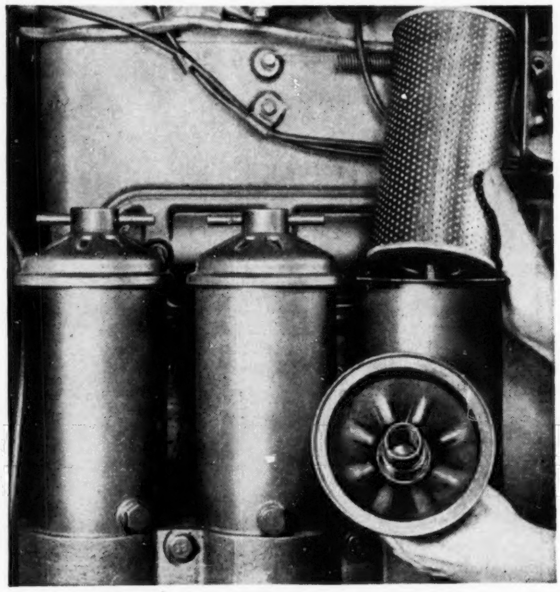
It's *Purolator** for Full-Flow!

- **Full-flow rates within practical filter dimensions:** Purolator's famous "accordion-pleated" Micronic* filter element has up to ten times more filtering area than old-style filters—gives high flow rates in a minimum of space.
- **Ultra-micronic filtration:** High flow rates are, of course, meaningless unless effective filtration is maintained, too. Electron micrographs prove that the Purolator Micronic filter stops particles down to *submicrons*—.0000039 in.!
- **Maximum dirt storage capacity:** The pleated design of the Micronic filter element provides many times more dirt storage space than old-style filters. This important advantage means uniform, efficient performance and a lengthy service life.
- **Minimum pressure drop:** The Purolator Micronic filter element introduces a remarkably small pressure drop in the lubricating system . . . permitting pumps of practical size and simple type.
- **Will not remove or absorb additives:** With Purolator Micronic filtration, you keep *all* the oil quality you pay for. The Micronic filter element will not strip additives . . . an important advantage with HD and heat-resistant oils

Modern engines with full-flow lube systems . . . which filter *all* the oil at each pass through the engine . . . demand the best in filters. And most leading makers of diesel engines and vehicles agree that the best is *Purolator** . . . a fact proved over and over by their own impartial tests.

The story's the same with gasoline engines, too! The world's best known producers of passenger cars, trucks, tractors, earth-moving equipment, and stationary engines have found Purolators best . . . and install them as standard factory equipment.

If you are contemplating new designs or modifications of existing ones, remember . . . there's a well-engineered and use-tested Purolator for *any* filter application, including fuel oil, gasoline, hydraulic fluid, and water. Write for the Purolator catalog issued for your special field.

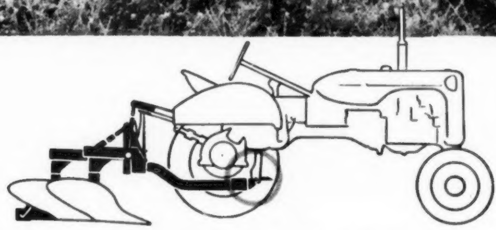


Purolator Micronic Filters in a typical Diesel full-flow installation. Although the Purolator Micronic filter elements measure only 4½ in. by 9 in., *each one filters 9 gallons of oil per minute*, giving a total of 27 g.p.m. for the complete filter unit.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey, and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles
*Reg. U.S. Pat. Off.

PUROLATOR
MICRONIC OIL FILTER
"FIRST IN THE FIELD OF FILTERING"

more work per horsepower



WITH ALLIS-CHALMERS

Free-Swing Implements

The sketch tells the story:

ONE Master Hitchpoint
Two Flexible Supporting Links

Allis-Chalmers plows, subsoilers, disc harrows and other heavy-draft, tractor-mounted implements are pulled like a swinging drawbar from a hitchpoint *ahead* of the rear axle of the tractor. On curves, this principle enables the load to *help* the front tractor wheels instead of fighting against them.

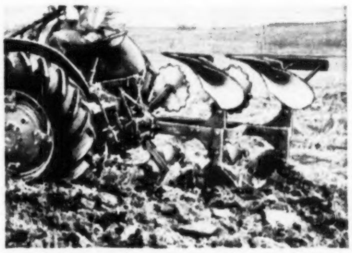
In Allis-Chalmers CA and WD Tractors, implement pull is "weighed" continuously by the "Traction Booster," and implement weight is applied to the rear wheels according to the pull on the drawbar.

A combination of hydraulically activated forces transfers extra weight to the rear wheels of the tractor to increase traction as needed. It is all done automatically by the regular hydraulic system, and is regulated by a small, conveniently located lever.

The result is more *work power* from engine power . . . without the inconvenience of adding and removing wheel weights.

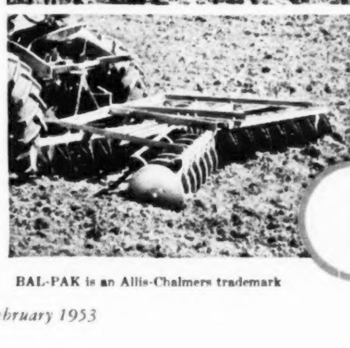
SEEING DOUBLE?

No — it's actually the new 2-furrow, 2-way A-C Spinner Plow that eliminates dead furrows and laps all furrow slices uphill. Conserves soil and moisture. Keeps land level for irrigation.



NEVER GREASE IT

New mounted disc harrows for CA and WD Tractors have lifetime-greased BAL-PAK bearings. Save time and grease, pull easier, last longer. Harrows are Free-Swing . . . free to go where tractor leads.

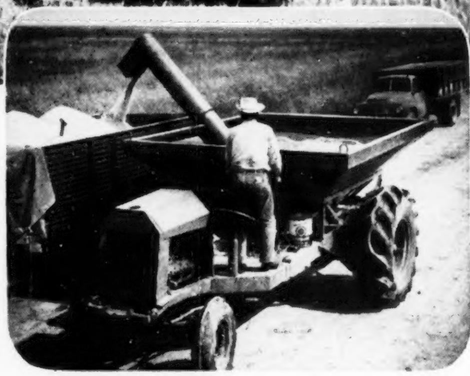


ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

BAL-PAK is an Allis-Chalmers trademark

"Doodlebug" solves harvesting problem in boggy rice fields

Taking a Load in Field—"Doodlebug" travels at same speed as combine. Mr. Byron Webb is shown operating the combine.



Unloading Into Truck: It's all mechanical, no hand labor is required. Mr. Webb (back to camera) operates controls.

Farmers were having trouble hauling their rice crops out of boggy fields until J. E. Bridges, of Beaumont, Texas, who repairs farm equipment, tackled the problem.

With the suggestions of local farmers, he developed the self-propelled grain cart or "doodlebug," shown above, with a capacity of 60 barrels of rice. It is powered by a Ford motor and can get in and out of boggy ground with ease, even when fully loaded.

Byron Webb—prominent rice farmer — saves time, trouble and manpower with his "doodlebug."

He has also found that *it pays to farm with Texaco Products.*

Maurice Nissley (left), prominent farmer of Manheim, Pennsylvania, gets a drum of Marfak from Texaco Man Clyde Mumper. Marfak sticks to bearings longer, won't jar off, dry out, or cake up. It forms a collar around open bearings, seals out dirt that can cause rapid wear.

Texaco Man A. W. Carlson (right) of Bollman Oil Co., Manlius, Illinois, delivers bucket of Havoline to Bud Russell on L. A. Dahl farm. Havoline exceeds Heavy Duty requirements, practically eliminates wear in gas or Diesel engines and those using L-P gas as fuel.

Dependable, neighborly service and top-quality products are what farmers and ranchers get when they call in Texaco Men or, in this case, Mrs. Louise R. Irving of Madras, Oregon, the Texaco Consignee there. Driver Russell R. Sumner waves good-by to Master Charles Van Cleef whose father farms 400 acres outside Madras.

TUNE IN . . . Metropolitan Opera broadcasts every Saturday afternoon. See newspaper for time and station.

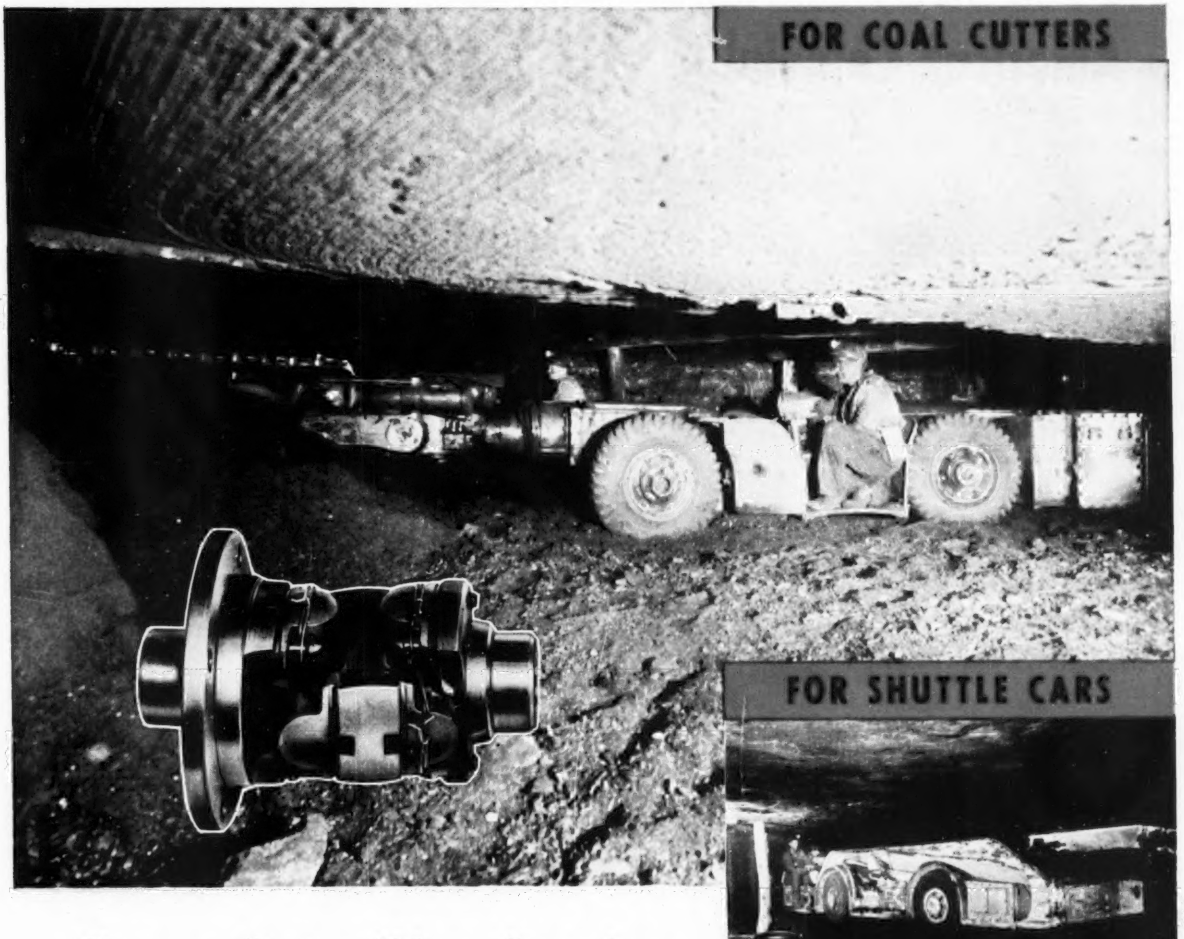
TEXACO

THE TEXAS COMPANY

IT PAYS TO FARM WITH TEXACO PRODUCTS

DIVISION OFFICES: Atlanta 1, Ga.; Boston 17, Mass.; Buffalo 3, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 5, Colo.; Houston 1, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 3, Minn.; New Orleans 6, La.; New York 17, N. Y.; Norfolk 1, Va.; Seattle 11, Wash.

Texaco Petroleum Products are Manufactured and Distributed in Canada by McColl-Frontenac Oil Company Limited.



Heavy-Duty Mine Service Requires MECHANICS Quality

In cramped quarters — where starts, stops and reverses are frequent — loads heavy and torque requirements severe — amid dust and moisture — MECHANICS Close-Coupled, Roller Bearing UNIVERSAL JOINTS serve dependably, safely and economically. They perform equally well in other rugged machines where joint space is limited and angles are extreme. Let MECHANICS engineers help with *your* joint problems.

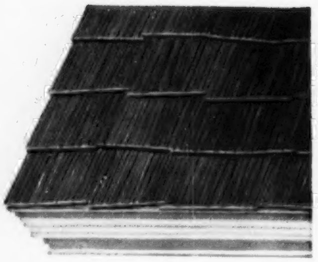
MECHANICS
UNIVERSAL JOINT
DIVISION
Borg-Warner
2046 Harrison Ave.
Rockford, Illinois

MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

American Colonial ASBESTOS SHINGLES

. . . add character to any home—
. . . wear like stone—
. . . applied like any strip shingle—



Each shingle is designed as a rigid asbestos-cement strip, covers as much area as 5 individual shingles. American Colonials are self-aligning, nail holes are pre-punched. Application is simple and rapid.

The finished roof has the pleasing horizontal shadow line and deep-grained texture desired by so many homeowners.

YOU LIFT your houses out of the ordinary when you give them a roof of Johns-Manville American Colonial shingles. These handsome, colorful shingles have the rugged, sturdy and fireproof qualities of asbestos and cement. In addition, they have new styling and striking new beauty.

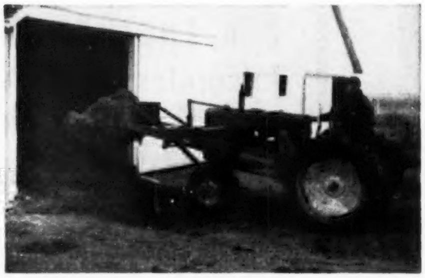
In most areas, the applied cost of an American Colonial shingle roof is lower than any other *permanent type* of roof you can use. The shingles are readily available nationally, easy to handle, and any carpenter can apply them. Your choice of several attractive colors. For full information write Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville**

MANURE PILE OR GOLD MINE?

*It can be just a manure pile, left to weather and lose value in the winter rains; or—if properly handled to increase crop yields—it can be worth easily $8 to $10 a ton.**

Protected from weathering, or scattered fresh in the fields, so that little is wasted, manure can be worth 40 per cent more than when it is piled in the open over winter. For example, packed manure loses only one-sixth of the amount of nitrogen that escapes from untramped manure. Manure in covered lot or shed, or pen-type dairy barn, is packed enough by stock to prevent much loss. It will suffer much greater losses from exposure to rains.



Most of the vital elements in manure can be saved, and returned to the land, by proper manure-handling methods. Modern equipment turns this old unpleasant job into one that's fast and easy.

WHAT'S MANURE WORTH? It varies with prices of farm products, with soil types, and other conditions. On Miami silt loam in Ohio, a ton of shed-stored manure raised crop yields during a rotation by 18 bushels of corn, 5 bushels of wheat, and 500 pounds of clover hay per acre. In another trial, on Wooster silt loam, the comparable yield increases were 24 bushels of corn, 10 bushels of wheat, and 1,280 pounds of clover hay per acre.

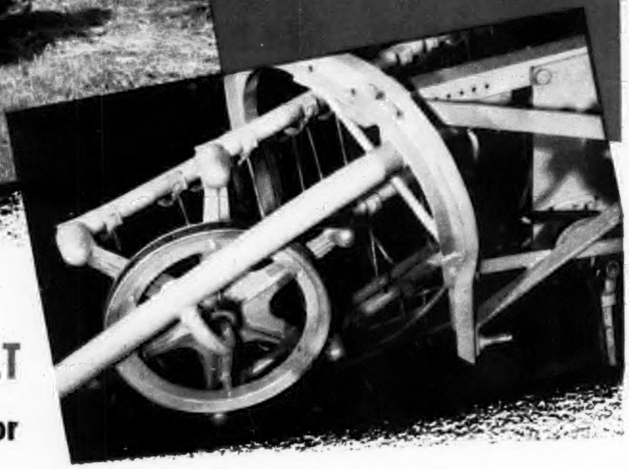
Results might be much different under other conditions of soil type, weather, the crops grown, the kind of manure, and so on; but the fact remains—manure is valuable. A ton of average fresh manure contains around 500 pounds of organic matter, 10 pounds of nitrogen, 2 pounds of phosphorus, 8 pounds of potassium—all elements that cost money if you buy them in the bag.

**All data from experiment station records*

JOHN DEERE

MOLINE ILLINOIS

The FERGUSON TRACTOR



DURKEE-ATWOOD V-BELT

Simplifies Power Transmission for Ferguson Side-Delivery Rake

The Ferguson Side-Delivery Rake is unit-mounted on the tractor and driven from the power take-off by a single Durkee-Atwood V-Belt. This drives the right-hand reel spider with no cams, gears or chains to wear out or cause trouble, and eliminates the ground drive with its usual slippage and complicated moving, driving and wearing mechanisms.

The six-bar reel and special offset placement of bars permits raking at speeds up to 10 miles per hour. Should the reel become jammed accidentally, the V-belt drive allows sufficient slippage for protection.

D-A ENGINEERING Integrates the V-Belt with the Application

Durkee-Atwood engineers collaborated with Ferguson engineers in overcoming design problems of the V-belt drive for the Ferguson Side-Delivery Rake. The result was a specially constructed V-belt that does an outstanding job.

If you have a V-belt problem, Durkee-Atwood's facilities are at your command. Ask Durkee-Atwood—your best source for engineering assistance and highest quality V-belts for agricultural equipment.

Form No. 545

DA PRODUCTS SINCE 1910

DURKEE ATWOOD V-BELTS

DURKEE-ATWOOD COMPANY

Dept. AE-2 MINNEAPOLIS 13, MINNESOTA

Suppliers of original equipment V-Belts for major manufacturers of:

COMBINES • MOWERS • HAY RAKES • FORAGE HARVESTERS
CORN PICKERS • WINDROWERS • CHOPPERS • COTTON PICKERS

why is U.S. KOYLON foam cushioning so important to you?

Many leading furniture manufacturers and designers have discovered that U. S. Koylon Foam is the ideal cushioning material for every purpose.

It is an evenly whipped foam. Millions of tiny air bubbles uniformly distributed throughout the foam provide more resilience and buoyancy for greater seating comfort.

And U. S. Koylon Foam gives furniture these added selling advantages...dust-free, odorless, non-allergenic, vermin- and moth-proof.

But *most* important to you, U. S. Koylon Foam gives marvelous latitude to furniture design. In molded cushions or in sheets, it's easy to work with, actually saves labor and time. And it maintains your reputation for excellence in the furniture field!

There's no finer cushioning than U. S. Koylon Foam.

Leading furniture manufacturers today feature U. S. Koylon Foam Cushioning

U.S.® Koylon FOAM Cushioning

UNITED STATES RUBBER COMPANY

ROCKEFELLER CENTER • NEW YORK

Saves . . . On Every Round!

The perfect combination for a good practice is the nimble Oliver "66" and the compact, handy 3-point hitch moldboard plow.

A "floating" plow linkage permits you to follow contours with very little variation in furrow width as you change direction. You do a better job of plowing...and save time, besides.

Plowing depth is controlled with the fingertip "Hydra-Lift" system. You can make short turns at the headlands, maneuver in tight spots and back into fence corners with ease. And, the No. 1214 Plow raises high—and fast—for passing over grassed waterways and turning at furrow ends.

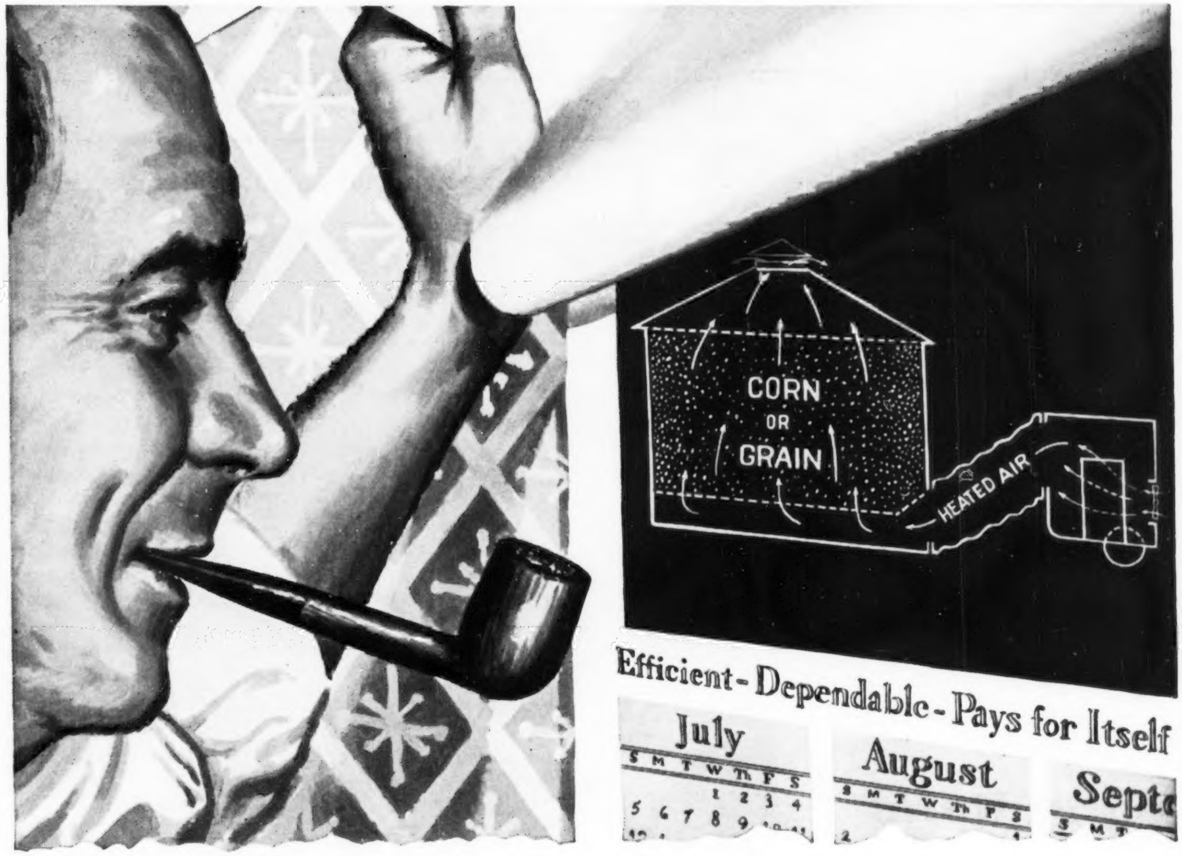
An Oliver "66" is your best 2-plow tractor choice, too. You have six forward speeds to fit any job...smooth, safe double-disc brakes that last longer...grouped controls and a comfortable rubber spring seat.

See your Oliver dealer, and see how much money Oliver's famous Raydex plowshares save ...how much time and effort an Oliver "66" saves. The OLIVER Corporation, 400 West Madison Street, Chicago 6, Illinois.

THE OLIVER CORPORATION

OLIVER

"FINEST IN FARM MACHINERY"



How to dry grain in the rain

By planning *now* to use modern drying methods, farmers won't have to depend on weather to dry crops next summer and fall.

These methods make it possible to cut hay or harvest small grain when it has reached the right stage of maturity – and dry it *properly* regardless of weather.

A steel bin or building with a perforated floor – used in conjunction with a portable crop dryer – takes the guesswork out of drying, saves field losses.

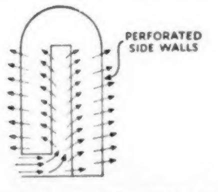
Steel buildings are ideal for crop storage, too. They're tight, fire-resistant. They keep the crop's food value in, keep rats and birds out.

Armco Stainless Steel and Armco ALUMINIZED in dryers assure high heating efficiency and high resistance to damage from a combination of heat and corrosion. In steel storage buildings, Armco ZINCGRIP gives long protection against rust.

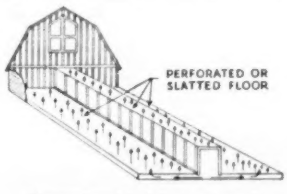
The cost? Tests show that modern drying and storing equipment more than pays for itself in extra profits. Fill out the coupon below for names of manufacturers who make and sell this equipment.

ARMCO STEEL CORPORATION

MIDDLETOWN, OHIO • THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE



Vertical steel building with perforated walls for drying ear corn or hay

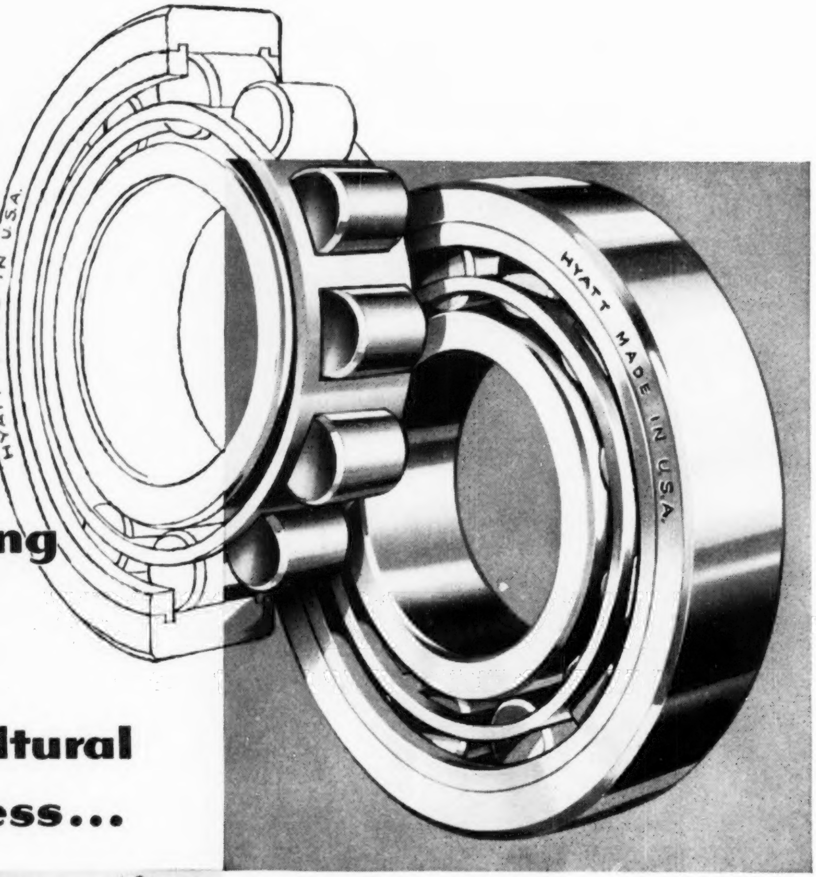


Conventional building equipped with center duct and perforated floor

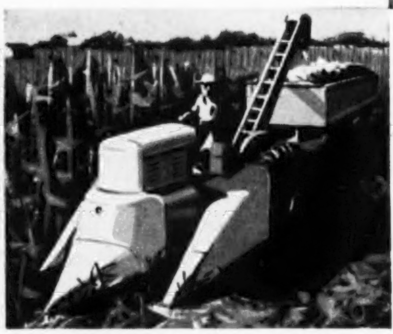
ARMCO STEEL CORPORATION
163-A Curtis Street, Middletown, Ohio

Please send me:
Further information on drying:
☐ Corn ☐ Grain ☐ Hay
☐ Names of portable crop dryer manufacturers
☐ Names of steel building manufacturers

Name ________
Address ________



Keeping pace with agricultural progress...



Hyatt precision bearings

Today's farmer depends on modern methods and modern machines to reduce his costs and give him the highest yield from his acreage . . . but mechanized farming is profitable only when the equipment gives maximum service without breakdowns. That's why so many leading manufacturers of tractors, combines, pickers, balers, sprayers and other farm equipment use Hyatt Roller Bearings. They know that with precision-built Hyatts smoothing the path of power, farm machines start more easily, carry heavier loads, and last longer with a minimum of maintenance. "Hyatt-equipped" is a sales feature well worth talking about—it's the farmer's assurance of highest quality in anything he buys. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

EDITORIAL

Advance Preparation for Engineering

IN RECENT months the engineering literature has made frequent mention of the current shortage of engineers and the likelihood of the scarcity becoming more acute in future years. Such agencies as the Engineering Man Power Commission of Engineers' Joint Council and the National Association of Manufacturers have rendered outstanding service in recognizing the problem and taking certain preliminary steps toward a possible solution.

However, many problems remain unsolved. One of the most perplexing of these relates to the evaluation of youth entering high school as to his "engineering potential" and the crystallization of his thought as to a career with some degree of preciseness at this stage of his development. Yet for meeting the entrance requirements and for satisfactory progress in an engineering college, there should be a high degree of continuity between the secondary school program and the prescribed college training for the student engineer.

Recruitment of high school seniors for careers in engineering is often only as effective as has been the over-all planning of their respective high school programs in this direction. Youth in the final year of their high school program, finding themselves deficient in such subjects as mathematics and the physical sciences, often turn to the liberal arts rather than retracing their footsteps and correcting their deficiencies for entrance into an engineering college.

Undoubtedly, the solution of the problem might be greatly facilitated if more effective ways and means be found to inform parents and secondary school teachers and authorities of the current urgent need and the likely continuing demand for technically trained personnel in general, and engineers in particular. However, the precise role to be played by the engineering college and university, as well as a professional engineering society, in this long-range recruitment program has not, as yet, been made clear.

A More Liberal Engineering Curriculum

THE literature of engineering education has in recent years often stressed the advisability of including in engineering curriculums more of the humanistic and social science studies. This has presented a real problem to the four or even five-year engineering curriculum builder in view of the requirements also for still more technical training in established fields of study, as well as including subjects from entirely new areas of scientific development.

Informal observations by a professor of agricultural engineering with more than 50 years of successful teaching experience is interesting in this respect. He points to the fact that the student can attend college for only a limited time, that four or five years, at least in the foreseeable future, is the maximum practicable length of the undergraduate curriculum. Inclusion of only those subjects considered essential by general agreement among engineering educators is in itself a most difficult problem. Adding the desirable "extras" is near impossible.

This man of wisdom, beloved by literally hundreds of engineers who has had such an important part in training, suggests the engineer-teacher be elevated to a more lofty level in the scheme of things at our engineering colleges and universities. Ability as a teacher, as an inspirational trainer and leader of youth might be more quickly recognized and highly valued by our educational administrators in these institutions. Too often in the past, according to this gentleman, recognition has been based, even in academic ranks, on ability to do research, to write and publish bulletins, and to successfully handle administrative assignments. Success in the classroom, success in the development of the major product of our colleges and universities has not always been properly rewarded.

When rightful recognition of the engineering teacher is achieved, standards for such teachers may be raised. They may be expected to have a more adequate background themselves in these same humanistic and social science subjects which many insist should be included in the undergraduate engineering curriculum. Then, according to this retired teacher, the elements of these subjects may be successfully imparted by the teacher of engineering to the engineering student while courses are being pursued in such technical subjects as calculus, heat transfer, and machine design.

His solution to this problem involves proper recognition of the teacher of engineering subjects; placement of the teacher on an equal plane with the staff member engaged in research, extension activities, or assignments of an administrative nature; demanding of the engineering teacher a high degree of training and proficiency in the humanistic and social studies; and, finally, the provision for an atmosphere and intimacy between teacher and student that not only will facilitate the imparting of technical knowledge but the elements of a more liberal education as well.

Operations Research

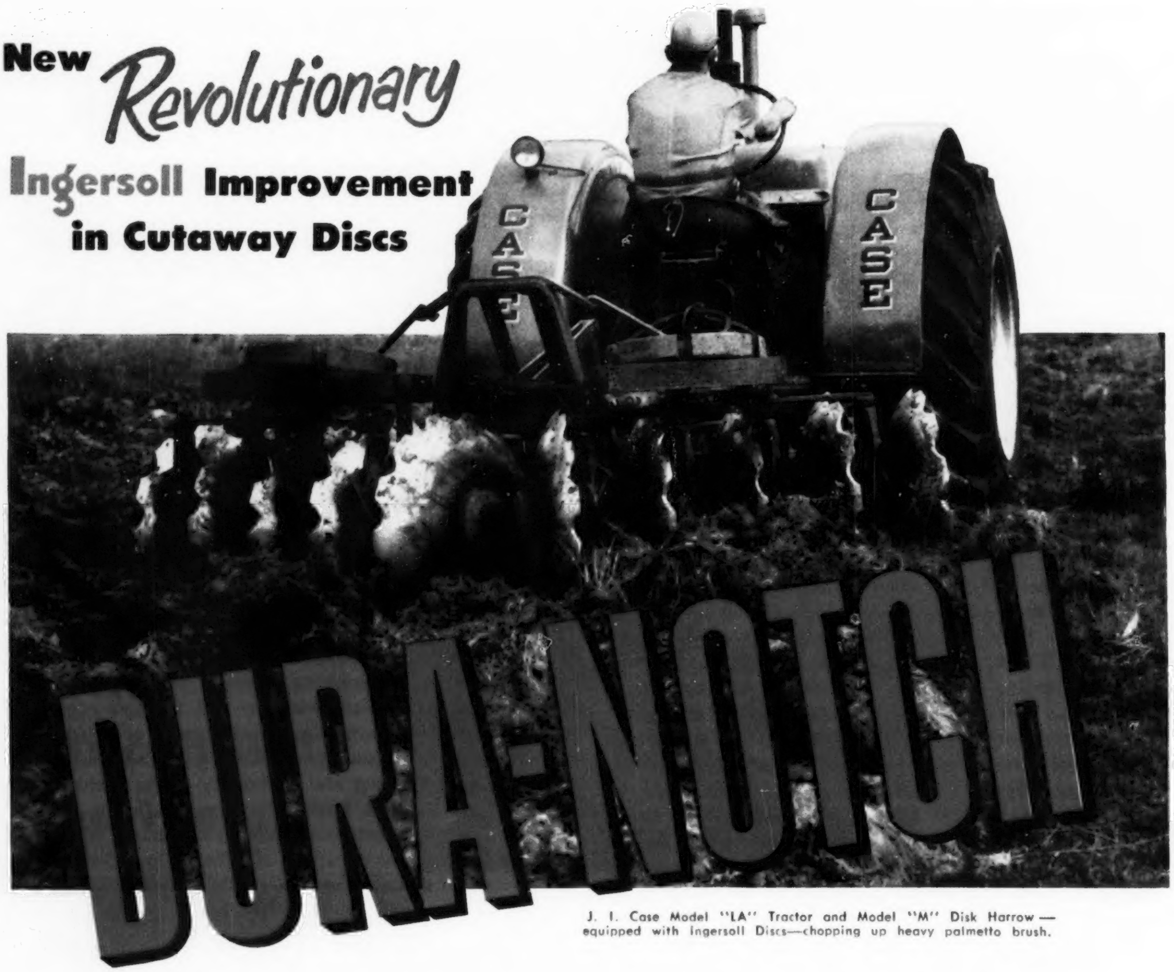
THERE may be implications significant to agricultural engineers in the growing interest in what is being called operations research.

In brief, it is the application of the methods of scientific research to operating problems of management. It is a means of providing additional quantitative evaluations as bases for executive decision. Its purpose is "to reveal basic relationships underlying the operations studied. . . . Theories of underlying mechanisms are sought which are consistent with facts brought out during operations or experimentation, and which can be used to predict the effects of changes in procedure or environment." The present concept carries somewhat beyond steps in the same general direction represented by cost accounting, statistical analysis, quality control, market research, and certain phases of industrial engineering. It is more inclusive than any one of these in its approach to evaluation of interrelated influences on the results of operations.

In farming, related business, and related public administration, some operators have a rare genius for management. Others are less fortunately endowed. Even the best managers, we surmise, will welcome opportunities to base more of their executive decisions on proven facts and figures. Agriculture may be served more effectively by engineers and engineered products when operations research removes more of the "ifs" which haunt new products and practices.

New *Revolutionary*

Ingersoll Improvement in Cutaway Discs



J. I. Case Model "LA" Tractor and Model "M" Disk Harrow—equipped with Ingersoll Discs—chopping up heavy palmetto brush.

No Grinding of Notch • No Grinding Cracks • Greater Impact and Shock Resistance

Here it is—the great new Ingersoll DURA-NOTCH—the remarkable new improvement in cutaway discs.

After years of research and experiment, Ingersoll has developed a new and exclusive method—*the Dura-Notch method*—of notching the cutaway. Instead of grinding it, the cutaway is punched out at an angle. The edge thus formed needs no grinding at all—so the danger of incipient grinding cracks is eliminated.

The result is a cutaway disc of superior ruggedness and strength throughout the curve of the notch—with terrific resistance to impact and shock. In impact tests, Dura-Notch discs withstood 15 blows of a 200-pound hammer dropped 40 inches, without breaking or cracking.* Not a single ground-notch disc made of the same analysis steel withstood more than 10.

Wherever the tillage job calls for cutaway discs, be sure to specify Ingersoll DURA-NOTCH discs. Like all Ingersoll discs, they're made better—to last longer.

*One Dura-Notch disc took 100 blows without failure!

ENGINEERING B-W PRODUCTION

DURA-NOTCH

INGERSOLL PRODUCTS DIVISION

BORG-WARNER CORPORATION • 310 S. Michigan Ave., Chicago 4, Ill.

Ingersoll

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The Engineer's Job in Developing America's Agricultural Capacity to Produce

By Robert M. Salter
MEMBER ASAE

WE ARE truly in the midst of a technological revolution, in industry, in military science, and in every field of physical and biological endeavor—including conspicuously the field of agriculture. The soil and water program of this meeting properly recognizes the major contribution which members of your profession have made to the advancement of soil and water technology, which is probably the principal development of the century in our agricultural economy.

Since the technology of soil and water conservation draws heavily upon engineering principles and techniques, it naturally follows that engineering is the basic specialty of many technicians in the U.S. Soil Conservation Service. They, along with specialists trained in soil science, agronomy, hydrology, forestry, biology and other subjects have built up an efficient corps of "soil conservationists." Their interests and skills extend well beyond their original field of specialization, without in any way sacrificing it. They are devoting their knowledge and energies to the conservation and improvement of our soil and water resources, without which we could not hope to prosper today or survive tomorrow.

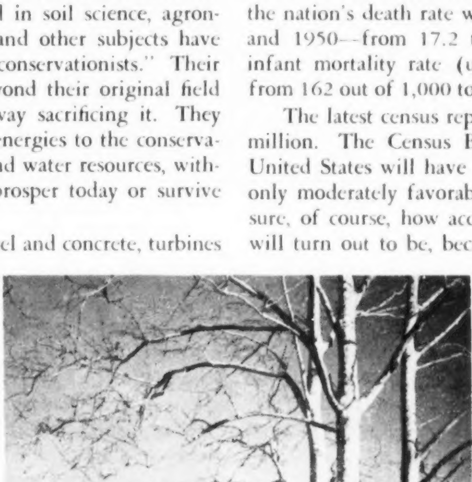
Jet planes and atomic bombs, steel and concrete, turbines and trucks, and bridges and buildings have become symbols of our nation's strength. Yet basic to it all are the products of the soil, without which neither military nor industrial strength can be achieved. An ample food supply is the basic foundation of our entire industrial system. Our whole economic structure is bolted to this foundation. Moreover, much of the raw material used in industry is produced from the soil, as are timber and other essentials. Almost two-thirds of all the new wealth created annually in the United States originates on our agricultural land.

Clearly then the big job ahead is to sustain production from the land in sufficient abundance to meet the needs of a growing population, of industry, of national defense, and of friendly nations abroad.

Our nation is still growing, and growing rapidly. Our population is increasing at the rate of some $2\frac{1}{2}$ million persons each year. In the U.S. Department of Commerce building in Washington, a lighted Census Bureau map equipped with a population "speedometer" records a net gain of one person in the United States every 13 seconds—one birth every 9 seconds, a death every 21 seconds, and corresponding computation of immigration and emigration.

The Brookings Institution has just issued a report, entitled "Health Resources of the United States," showing that the nation's death rate was cut almost in half between 1900 and 1950—from 17.2 to 9.6 per 1,000 population. The infant mortality rate (under 1 year of age) has plunged from 162 out of 1,000 to only 31.

The latest census report shows that we now number 157 million. The Census Bureau estimates that by 1975 the United States will have a population of 190 million, under only moderately favorable conditions. Nobody can tell for sure, of course, how accurate these estimates for the future will turn out to be, because the controlling social and economic factors involved do not lend themselves to precise slide-rule calculation. But even by the most conservative forecasts of our population's growth, America's agricultural capacity to produce must be increased substantially in the years ahead. Your job and mine in helping to expand and maintain agriculture's capacity to produce presents a challenge worthy of our best talents.



In the job of helping the industry of agriculture to maintain and expand its capacity to produce is presented a challenge worthy of the best talents of the agricultural engineering profession

First of all, of course, agriculture's ability to continue producing in the abundance needed depends upon maintaining strength in our land. To meet future needs will require much greater productivity from the more or less fixed acreage of crop land and pasture land we have available.

The research administrator of the U.S. Department of Agriculture in a recent analysis arrived at the conclusion that to maintain

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The author—ROBERT M. SALTER—is chief, Soil Conservation Service, U.S. Department of Agriculture.

our present standard of living in the United States will require the production equivalent of 115 million acres of additional crop land by 1975. That is based on the assumption of population growth at only moderate rates. To improve our standard of living at the rate it has improved during the past 15 years would require the production equivalent of 165 million acres of new crop land.

SCARCITY OF NEW LAND SUITABLE FOR CROPPING

We don't have 165 million acres, or 115 million acres, of new land suitable for cropping to bring into production by 1975. The President's Water Resources Policy Commission in its 1950 report estimated that 30 million new acres might be brought into crop production by 1975 through irrigation, drainage and clearing. The USDA research administrator estimates that we might pick up another 15 million acres as a result of further farm mechanization and the consequent shift of that acreage from feed production for draft animals to production for human consumption. These potential cropland figures are far short of the cropland equivalent that is going to be needed. Furthermore, they do not take into account that a substantial acreage of land now being cropped should be, and undoubtedly will be, taken out of crop production by then.

Nor do they allow for additional land that may be lost to economic crop production through continuing erosion and soil deterioration. This type of land loss will continue until the application of conservation technology on the farm lands of this United States becomes far more widespread. Industrial and home sites, roads and so forth also take good land out of production.

Despite our intensive efforts for soil conservation and the gratifying progress made on much land, we have nowhere near stopped soil erosion or soil depletion for the country as a whole. Our land generally is still deteriorating faster than we have managed to build it up.

In the Midwest and in the Great Plains, for example, which include a large area of our highly productive land, it was estimated in 1950 that inherent soil productivity was declining at the rate of 0.7 per cent a year. Moreover, more than 5 per cent of our cropland lies in the valleys along upstream tributaries of rivers and other streams. Every year about 75 per cent of this valley land, which is potentially our most productive land, is flooded at least once, with resultant damage well known to all of you.

We can't ignore these facts about our land situation. Nor can we resolve them by merely talking about them. We must *do* something about them. We must do everything possible to increase and maintain higher levels of soil productivity. Fortunately we now have much improved soil and water technology that can help to reverse the downward trend in soil productivity. The problem is to get it applied on the land.

Soil conservation is not just a matter of "gully plugging." Neither is it simply a matter of building terraces, dams and other mechanical controls for soil erosion. The soil conservation job involves the application on the land of all necessary measures in appropriate combinations to build up and maintain soil productivity for efficient, abundant production on a sustained basis. It is the basic principle of using land according to its capabilities and treating it according to its needs.

Conservation farming may appear to the layman to be simple as he drives along the road and looks at even such more elaborate patterns as contour strip-cropped fields. But conservation farming is not simple, and it is not static. Because of the complexity of soils alone, the soil and water conservation technology itself is highly complicated. Variations in climatic, economic and other conditions are further complicating factors that have to be taken into account.

CONSERVATION FARMING INVOLVES MANY PRACTICES

Land use and soil treatment must be related specifically to the pattern of land and water resources of the individual farm or ranch, as well as to the resources and aptitudes of the farmer. Conservation farming can seldom be achieved by a single practice. Instead, a combination of methods is needed, a combination fitted to the specific soil characteristics and other needs. Obviously few landowners or operators possess the training or skill for planning and applying such complex measures. That calls for engineering, agronomic and various other technical knowledge and skills.

By the same token, no one specialist may be expected to possess all the knowledge needed in those different fields, although it is essential that he have sufficient working understanding of them to fit his own particular techniques to specifications developed by other technicians. That is why engineers, agronomists, foresters and others with special knowledge need to pool their skills in dealing with the varied conservation problems involved.

Getting the conservation job done in the most effective and economical manner possible requires practical teamwork among the various specialists. A farmer is more concerned


Drainage and irrigation rehabilitation and improvement and erosion control on sloping land present challenging engineering problems in planning and applying modern soil conservation. The Caterpillar equipment in these pictures shows *(left)* a tractor and bulldozer putting in a surface drainage ditch and *(right)* a motor grader building a terrace on rolling land.

with sound recommendations than whether one technician works on his place for three weeks or three technicians do the job in one week. Through technical teamwork ill-advised recommendations are avoided on unusual or more complex engineering, agronomic or other problems by referring them promptly to the best qualified technician available in that field.

After the soil conservation program started in the 1930's cooperation among the differently trained specialists developed rapidly. The nation was fortunate to have many technical specialists in the different parts of the country who had the necessary broad, sound training and experience which enabled them to adapt their skills readily to the coordinated soil and water conservation concept. Agricultural engineers were prominent among these trained specialists.

The transition has been made from "civil engineers in agriculture" to bona fide "agricultural engineers," trained to adapt engineering principles and techniques to land, cropping and related problems. When the ten erosion control experiment stations were established in representative agricultural areas of the country more than 20 years ago, engineers, soil scientists and plant specialists were brought together to study not only the causes of soil erosion through action of wind and water, but also to develop jointly measures for controlling it. It was on these stations that engineers had the first real opportunity to learn how land cover, proper tillage and other land-use measures affect the amount and rate of water runoff, and their impact upon the design of structures to help control runoff.

One of the most pressing and least understood problems was that of water runoff from small areas. The soil conservation engineer, through research and field experience, has made a major contribution in this field of agricultural hydrology, in which research and improved methods of dealing with the farmland water management problems involved continue to be carried on.

BEGINNINGS OF SOIL-AND-WATER-MANAGEMENT PRACTICES

With the creation of the Soil Erosion Service in 1933, which became the Soil Conservation Service in 1935, erosion control and water-management practices based on painstaking research and cumulative experience in every day application were placed on the land under widely diversified conditions. Engineers, soil and plant scientists and biologists all had the opportunity of observing, for the first time, how their techniques supplement each other.

Thus the engineer saw the need for using land cover and good soil management to make his structures more effective, and to lower the cost of building. From the wide amount of conservation construction work which was done on farm and ranch lands, supplemented by continuing intensive research on the stations, designs were developed that are more effective from the hydrologic standpoint and from the standpoint of their more efficient and economical construction. The proper place of such engineering works as terraces, gully-control structures, farm and ranch ponds and water-distribution devices in the basic conservation farm plan likewise came to be understood.

The American Society of Agricultural Engineers recognized the opportunities and responsibilities of the agricultural engineer in the newly opened soil and water conservation technology when, in the early 20's, it set up what is now known as its Soil and Water Division. By 1935 the Soil Conservation Service had begun to direct more attention to land-use problems in connection with drainage and irrigation, which historically had been fields of major contributions by the engineer in agriculture.

Since that time substantial progress has been made in applying engineering principles to the land for soil protection and improvement. Agricultural engineers have made a major contribution to soil conservation in the United States. All of the engineering opportunities, however, are not exhausted. On the contrary, even bigger challenges lie ahead.

Drainage and irrigation rehabilitation and improvement, flood prevention and erosion control on sloping land all present challenging engineering problems in the planning and applying of modern soil conservation.

MILLIONS OF ACRES NEED DRAINAGE IMPROVEMENT

Drainage improvement, for example, still remains to be carried out on millions of acres, in the interest of better land use and expanding crop production. This acreage includes land now being farmed that would benefit by drainage, other lands that are partly but improperly drained and accordingly do not produce as they should, and undeveloped swamp areas that well might be brought into production, after it is determined they are not better suited and more desirable for wildlife, water conservation or other use. In any event, conservation drainage systems, in the development of which the engineer has such an important part, are designed to meet the land treatment and use requirements determined by the soil scientist, agronomist and others technically concerned in the basic farm conservation development.

The same is true with respect to conservation irrigation improvement work. And here again we find crop and hay lands that are far below par in production, because of inadequate irrigation systems or improper water use. That is not to mention the damage being done to the soil through waterlogging, leaching and surface erosion, and accumulation of salts.

Moreover, there are thousands of farms in the humid areas, as well as many more acres in the West itself, on which the opportunities for supplemental irrigation are enormous. Engineers have a real opportunity to perfect further practicable techniques for applying water to growing crops so that more moisture is available to crops and less is wasted. There are, also, complex problems of engineering and soil-water-plant relationships involved in the change-over from dryland to irrigation farming. The need for research and technical assistance in such areas has prompted special attention to soil and water conservation and engineering investigations in new reclamation areas.

A newer and virtually unbounded category in soil and water conservation is that of watershed development and upstream flood-prevention work. There is a growing public awareness of the fact that the damages which occur along such major streams as the Mississippi and Missouri rivers during spectacular floods actually are but a part of our total flood cost. Watershed treatment includes, in addition to conservation cropping, range management and forestry measures, many such works of improvement as smaller floodwater retention dams and reservoirs, diversions, channel stabilizing construction and others.

The role of the agricultural engineer in this growing field of conservation is self-apparent. And its importance is underlined by the increasing number of urgent requests to

soil conservation districts for assistance in developing community watershed programs, including drainage outlets, protection of municipal reservoirs, improvement of stream flow for fishing and other recreation, as well as local floodwater protection. The Soil Conservation Service is providing technical assistance in more than a dozen community watersheds and expects to continue to cooperate in such enterprises within the limits of its facilities.

Watershed development involves a great many measures in which the special services of the agricultural engineer are specifically required. Broadly, these cover a range of engineering techniques from laying out true contour or other precision lines and structure designs to farm machinery adaptations. Fully as much care, if not the same degree of precision, is necessary in laying out contour strips on cropland or contour furrows on range land, let us say, as in laying out a farm drainage or irrigation system. Terraces and diversions, involving earthmoving operations as well as determining level and gradient, likewise call for competent engineering design. So do farm ponds and stockwater dams, field and other waterways, gully structures, streambank stabilization works, and many more.

I want to underscore the fact that the engineering phases of soil and water conservation cannot be set apart or isolated from the soils, vegetative and other phases, which, all together, comprise the technology for soil and water conservation. No one knows better than an engineer that a drawbar coupled off-center from the line of draft causes one-sided pull, wastes power and results in a poor job of plowing or other operation. There is too much ground to cover in soil and water conservation, and too short a time in which to cover it, to waste technical manpower or to settle for anything short of utmost efficiency in getting the job done. That is why the engineering, agronomic and other parts of the program cannot do otherwise than occupy roles of comparable responsibility, with the respective specialists pulling their full share of the load.

The agricultural engineer in conservation works with farmers, with private contractors and with other conservation technicians. Working with the soil scientist, for example, the conservation engineer relates engineering and other treatments to soil structure, slope, rainfall and runoff, and so on. It would be unwise to locate and build a farm pond or stockwater dam, for instance, without having all of those facts to go on.

AGRICULTURAL ENGINEER WORKS WITH SPECIALISTS

The agricultural engineer is especially conscious of the effect of vegetative cover, and accordingly works closely with the agronomist, range specialist, or forester. He knows that when the placement and use of such structures as dams and waterways are keyed in with vegetative programs of conservation cropping, pasture and woodland management, their design may be altered accordingly, for increased efficiency and economy. In fact, one of the first principles to become apparent in conservation engineering practice was the effectiveness of vegetative cover, above farm ponds, on terraced fields or elsewhere, in reducing the maintenance of structures, because of the cover's effect on silt movement and runoff characteristics. The effect of watershed cover on runoff and movement of silt also is taken into account in the design and location of structures.

Thus grassland farming, from improved methods of pasture seeding and growing of grass and legumes in rotation on cropland to deferred grazing and other rangeland conservation practices, helps the engineer in applying his technology. It in no way conflicts with sound and needed engineering practice for conservation. The mutual functions of vegetation and mechanical controls are many, including grass to stabilize waterways and protect fills of dams; grass, legumes and woody plants to heal graded-in gullies; streambank stabilization plantings, and others.

Soil and water conservation, however, cannot be attained solely by putting physical improvements on the land, whether those be man-built structures or nature's growth of grass or trees. Of primary importance, also, is the way in which we *use* our land, particularly the methods of tillage by which we produce cultivated crops and the machines we employ in doing so. The agricultural engineer has contributed measurably to the progress we have made along these lines, as he has so greatly to the entire field of farm mechanization. But there is the continuing need for him to exercise his talents in the development and adaptation of equipment that is of maximum effectiveness and efficiency in conservation farming operations.

There is more involved than machinery design. Also basically important is the determination of methods by which various soils can most efficiently be put into condition during the cropping season to improve their productiveness instead of furthering their deterioration through erosion, fertility depletion and breaking down of desirable soil structure. Here again the technical teamwork of the engineer, the soils specialist and the agronomist is essential.

MODERN EQUIPMENT FOR CONSERVATION PRACTICES

Modern farm equipment already has come to include many tools by means of which conservation and soil-building practices are being readily incorporated into everyday farming operations. The Soil Conservation Service long has given closest attention to determining how all types of farm equipment can be adapted most readily to such conservation farming operations as contouring, stubble-mulch tillage, grass and legume seeding and the like. This has been done both through research and field operations, in cooperation with the Bureau of Plant Industry, Soils, and Agricultural Engineering, state agricultural experiment stations, and the farm equipment industry itself.

Effective tools and excess power can, if improperly used, produce destructive results as easily as good results in breaking and tilling soil. In fact, much of the serious erosion on cropland since World War I may be blamed upon indiscriminate use of implements expertly engineered for different kinds of plowing and cultivating, coupled with the reserve of farm power which came with the development and widespread use of the farm tractor. The fault, of course, has been not in the equipment but in its operation — just as drivers, not the automobiles themselves, cause all but a negligible percentage of accidents on the highways.

It certainly would be wrong, though, to blame the motives of the farmer because he has done the natural thing in taking advantage of his high-powered machinery to plow too deep and clean, operate at too fast a speed, or cultivate critically steep slopes or tight soils and wet soils. This is where the agricultural engineer, the soil conservationist and other qualified specialists have a real service to perform. Part of the job is to help avoid the harmful effects through

excessive tillage, use of the wrong machines or wrong use of the right machine. Another part of the job is to design equipment to meet conservation needs, such as grass-seeding equipment for native species in the Great Plains and elsewhere, equipment for better moisture management, and special machines such as potato planters adapted to stony, sloping lands in the Northeast.

I mention those as illustrations of the many such conservation-adapted tools that have been developed in different parts of the country, ranging from a variety of subsurface tillage implements to special grass and legume seed-harvesting and cleaning machinery. The main objective, of course, is to see to it that engineering methods and power machinery contribute to better planned over-all operations and to more efficient per-acre production. We accordingly are vitally interested in working with the farm equipment industry to develop the most effective means of applying modern farm machinery to the job of establishing cropping practices that build the soil and eliminating practices that deplete the soil.

FITTING MACHINES TO NEEDS OF CONSERVATION FARMING

The Soil Conservation Service also recognizes its responsibility for keeping the farm machinery industry informed as to what needs to be done, on the basis of conservation research and field experience, in soil treatment and management for assuring optimum yields on a permanent basis. Undoubtedly most of you know about the special nation-wide program that has been undertaken cooperatively by the farm equipment industry and the soil conservation districts for encouraging all of these things I have mentioned. Through this program, the farm equipment industry and conservation farmers are teaming up to solve more of their problems as they arise, respectively, through the local dealers and the soil conservation district supervisors and assisting technicians.

I have limited my comments largely to the contribution of agricultural engineering to soil conservation in the United States. I did so deliberately to underscore the significance of that contribution. In so doing, I intend in no way to subjugate the enormous contribution to improved agriculture that you engineers have made through farm mechanization.

Farm mechanization deserves a large share of the credit for making possible today's efficient agricultural production in this country, releasing to industry and the professions a high percentage of the man power which provides the off-the-farm goods and services for our high standard of living. A hundred years ago, each farm worker produced enough food and fiber for about 5 persons. By 1900, he still produced enough for only 8 people. But today each farm worker produces enough for 15 people.

Since 1910, the farm output per man-hour has increased 120 per cent, while the man-hours worked have decreased 18 per cent. That is why it has been possible for our farm population to drop 25 per cent in this same period and, as the 1950 census revealed, for 84 per cent of all the people in the United States to earn their living in towns and cities. The fact that 16 per cent of our population can grow the basic materials essential to feed, clothe and shelter all of us is the basic reason we can have such a high standard of living in this country.

Your profession should take great pride in the outstanding contribution you have made to the betterment of our country through the mechanization of agriculture. That has been your major contribution of the past quarter century. But farm mechanization is now well along. I believe one of the big challenges for your profession during the next quarter century lies in the field of soil conservation and improvement. I have tried to outline some of the opportunities in this field as I see them.

For the agricultural engineer in the years ahead to make his full contribution in helping to expand the capacity of American agriculture to produce, he must be more than just an "engineer in agriculture." He must accept responsibility for aiding in solving the over-all problems of agriculture, by adapting his engineering techniques to the problems. He must have a broad understanding of those over-all problems of agriculture in order to apply his engineering skills effectively and to the greatest good.

In the field of soil and water technology, his job does not end with unrelated calculations and blueprints for structure design or machinery modifications. Soil and water technology, as we have seen, is not static—the whole production job ahead in agriculture is not static. Therefore, it naturally follows that the work of the agricultural engineer is not static, and I am convinced that in the years ahead emphasis in your profession will shift more and more to the application of engineering to specific soil problems with engineering skills becoming teamed more and more with the other specialized skills in agriculture.

Your profession has both an opportunity and a challenge for the future to help farmers further expand agriculture's capacity to produce.

Limits of Engineering Manpower

AN EDITORIAL

WITH all that has been said about the current shortage of engineers, it is still difficult to appreciate the full significance of the situation.

In a notable recent contribution to such understanding S. C. Hollister, dean of engineering at Cornell University, has indicated that we have in the United States about reached the practical maximum percentages of our manpower to complete basic engineering training and of engineers in our total male population.

His figures are based in part on Army General Classification Score records from World War II. They provide the largest sample of our population ever subjected to any one single test.

He estimates that of our current 1,100,000 young men reaching the age of 18 each year, 17 per cent are above the intellectual level represented by the Army GCT score of 120, which he considers a minimum requirement for engineering. This figures out to 187,000 possible prospects.

The personnel requirements and attractions of other fields of work, personal preferences, other requirements of engineering training, and various obstacles to undertaking engineering training reduce the freshman engineering class to a practical national total of 44,000. This is 4 per cent of our young men reaching college age and about 23.5 per cent of the 187,000 who are possible prospects from an intellectual standpoint.

Attrition due to various factors during the school years cuts the graduating class in engineering to half of the starting numbers, a current expectancy *(Continued on page 124)*

Factors Influencing Drainage Design in Irrigated Areas

By Ronald C. Reeve
MEMBER ASAE

DRAINAGE as applied to agriculture is defined as the process by which excess water is discharged from soils. Where water is discharged by surface flow, it is termed "surface drainage," and where it is removed by passage of water through the soil, it is termed "internal drainage." The term drainage is also used to refer to the means by which excess water is removed, such as streams, open ditches, tile drains, pumped wells, etc.; and sometimes it is used to designate the water that is removed itself. Definitions of the term drainage together with other related terms pertaining to water-movement processes in soils have recently been proposed by a subcommittee of the Soil Science Society of America (13)*. The above definition pertaining to the process by which excess water is removed from the soil is recommended as the preferred definition and will be used in this paper. For the latter two meanings of drainage, the terms "facilities" and "water" are implied, and when the means by which drainage is accomplished or the water itself is meant, the terms "drainage facilities" and "drainage water" seem appropriate.

Drainage design, for a given unit or area, can be reduced to a consideration of three quantities: (a) drainage requirements, (b) water-transmission properties of the soil, and (c) boundery conditions.

Drainage Requirements. The drainage requirements involve both the adequacy of drainage and the quantity of water to be drained. The adequacy of drainage for agricultural purposes appears to depend upon whether or not there is an excess of water on or in the soil. In areas where salinity is not a factor, such as in humid regions in which the required moisture for crops is supplied largely by rainfall, the drainage requirements are related to the oxygen status and the soil-water relationships as they influence crop growth. The optimum moisture content of the soil for tillage and other farming practices is also an important factor. The drainage requirement under these conditions may be expressed in terms of a period of time for removal of a given quantity of water and depends upon the susceptibility of the crop to damage by exposure to excess water or to the seriousness of delaying farming operations.

In arid regions drainage requirements are appreciably altered by the salinity factor. Whereas exposure to excess water may be the controlling factor in many cases in irrigated areas, more often the drainage requirement is determined by the salinity factor. Irrigation waters contain soluble salts which, when applied to the land, are concentrated in the soil by the processes of evaporation and transpiration. In order that the soil solution does not reach a concentration that is detrimental to crop growth, excess water must pass beyond the root zone and leach out excess soluble salts. Knowing the consumptive use, the amount of water that must pass through and beyond the root zone to provide the required amount of leaching can be estimated on the basis of the salt content of the irrigation water and a permissible concentration of the drainage water. This leaching requirement is an estimate of the minimum amount of water that must be drained away. The total quantity of water required to be drained will be greater than the leaching requirement by an amount equal to the losses that reduce irrigation efficiency plus any other sources of water that contribute to inadequate drainage, such as seepage from canals, regulatory waste, artesian sources, etc.

In addition to the quantity of water that must be drained, which for design purposes may be expressed as a rate of flow, a minimum allowable water-table depth to prevent damage to crops, either from excess water in the root zone or from the concentration of salts in the soil by upward flow, must be established. The minimum allowable depth depends upon the crops to be grown, the soil conditions and the salt content of the drainage water. The principal requirement in any case is that the depth to water table must be such that the upward movement of salts from ground water into the root zone can be conveniently controlled. If an adequate water-table depth cannot be maintained, irrigation and management practices can sometimes be altered to allow crop production even though drainage conditions are not ideal. Improvement of irrigation efficiencies and more uniform application of water are examples of ways by which drainage conditions can be improved and a net downward movement of salts maintained.

Irrigation efficiency, distribution losses, regulatory losses, rainfall, salt content of the irrigation water, and salt tolerance of crops all enter into the problem of determining drainage requirements.

Water Transmission Properties of Soils. The principles and background theory of flow in porous media are well known and adequately treated in the literature. A discussion of the forces and properties determining the flow and distribution of water in soil, both saturated and unsaturated, and a description of measuring methods is given by Richards (12). An important part of the background theory is embodied in the well-known Darcy equation which in its generalized form states that for isotropic media the flow velocity (specific discharge), which is a vector quantity, is proportional to the hydraulic gradient and is in the direction of the greatest rate of decrease of hydraulic head. The proportionality factor, termed hydraulic conductivity (13) is a measure of the readiness with which soils transmit water.

Of the several basic factors which govern flow in soils, the transmission propeıties are the most difficult to evaluate, primarily because of the extreme variability of soils. Many of the soils in arid regions are formed by alluvial deposition and are therefore extremely heterogeneous and non-isotropic. The problem of appraising the over-all or composite water-transmission rate of a soil as related to a given drainage or flow condition involves not only the mechanics of determination but a problem of statistical sampling as well. From the standpoint of drainage, where absolute values are important, there are several field methods that have been developed for

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*Numbers in parentheses refer to the appended references.

determining the hydraulic conductivity of soils that appear to have considerable promise. The auger-hole method, first used in Holland by Diserens (2), later improved by Hooghoudt (4), Kirkham and van Bavel (6), and van Bavel and Kirkham (14), is useful in non-stratified soils. The piezometer method proposed by Kirkham (5), for which methods and procedures using large-diameter tubes were developed by Frevert and Kirkham (3), and for small-diameter pipes by Luthin and Kirkham (7), is useful in both uniform and stratified soils. These methods all make use of a cavity formed in the soil below a water table and the rate at which water flows into or from the cavity is a measure of hydraulic conductivity. Constants which take into account various geometrical factors are obtained by empirical methods.

Undisturbed cores may be useful in many instances, but methods utilizing larger samples are preferred where soil variability is a problem. Reeve and Kirkham (10) showed that the relative size of sample associated with the undisturbed core (2-in diameter by 2 in long), piezometer (1-in diameter with a cavity 4 in long), tube (8-in diameter with a cavity length equal to zero), and the auger hole (4-in diameter by 30 in deep) are in the ratio 1, 35, 270 and 1400, respectively, the latter three values being based on the region in which 80 per cent of the hydraulic head is dissipated.

Boundary Conditions. Boundary conditions may be considered as constraints that govern the pattern of flow within a given ground-water flow system. The boundary conditions involve the location of boundaries and the hydraulic head and the water-flow conditions that occur over the surface that bounds the problem. Topography, stratigraphy, and location of sources of water are the principal factors that define the geometric aspect of the boundary conditions of a given area. Drainage structures, per se, are also boundaries by which flow may be controlled to provide favorable conditions for crop growth.

Evaluation of the boundary conditions provides the basis for the design of drainage systems. Many irrigated areas of the West are in alluvial intermountain valleys where topography and stratigraphy vary widely and excess waters arise from many sources. Thus these factors which are a part of the boundary conditions appear to have greater significance in arid regions than in humid areas. In the latter case, rainfall is the principal source of water and topography and subsoil stratigraphy are generally less variable.

Topography is readily evaluated by standard engineering and mapping practices, and much useful information for designing drainage systems is obtainable from topographic and aerial maps. They can be used to delineate places where drainage is likely to be a problem and to locate seeps and springs, benches, abrupt changes in slopes, old stream channels, soil changes, etc., which have an effect upon drainage conditions.

Stratigraphy is an important consideration in drainage design. The effectiveness of drainage structures is related directly to their location with respect to subsoil layers. Water lost from deep percolation in one area may come to the surface in another, or appear as a seep on a sidehill slope, depending on subsoil formations. Permeable layers may beneficially discharge excess waters from an area or may serve unfavorably to transport water from one area to another. Impermeable barriers may intercept conducting layers and block free flow of ground water. Proper orientation and placement of drains may be the most important single factor in the design of a drainage system. In general, it may be stated that the most effective method of drainage, in any case, is one that takes advantage of the most permeable materials in the profile.

Apparatus for studying subsoil materials include hand augers, power augers, driven tubes, standard well-drilling equipment and jetted piezometers. The installation of piezometers by jetting (8, 9, 11) has been shown to be an effective and economical method of determining subsoil stratigraphy and of obtaining hydraulic-head readings for groundwater flow appraisal.

Jetting equipment which has been successfully used in the Coachella Valley, California, is described by Reger et al (11). Piezometers have been installed in this area and soils logged to depths up to 150 ft at costs of less than one-tenth that of standard drilling methods. Subsoil logs are usually made on the basis of texture as an indirect measure of the water-transmission properties of soils. Depth of strata changes may be determined to within $\pm$ 0.1 ft with this equipment. An estimate of texture and consolidation of the material is made from (*a*) the vibration or feel of the pipe to the hands on the downward motion, (*b*) the rate of downward progress, (*c*) examination of sediments carried by the effluent, and (*d*) observation of color changes that occur in the return flow around the outside of the pipe.

Sources of water that may contribute to adverse drainage conditions include rainfall, irrigation runoff and waste, creeks and streams, ground-water flow, artesian aquifers, deep percolation from irrigation and seepage losses from canals. An inventory of all water sources is necessary for effective drainage design. Frequently, preventive measures can be applied to reduce the quantity of water that must be drained, thereby minimizing the amount of drainage construction required. Surface sources of excess water are readily evaluated by standard engineering practices, whereas

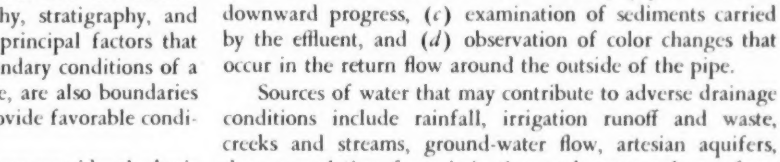

Fig. 1 Profile flow pattern showing the hydraulic-head distribution and direction of flow in the vicinity of an open drain under artesian conditions

special techniques are required for appraisal of ground-water flow.

Ground-water flow may be expressed in terms of energy. Hydraulic or piezometric head is a convenient expression of the potential energy at any point in a ground-water flow system and is a quantity that is easily measured. Hydraulic or piezometric head at each point in the soil-water system is the sum of elevation head and the pressure head, the velocity head usually being negligible. It is simply the elevation, referred to any convenient datum, at which water stands in a piezometer connected in the soil to the point in question.

The direction of flow, for the isotropic case, is in the direction of the hydraulic gradient which is the direction of the greatest rate of decrease of hydraulic head. For practical purposes, a knowledge of the hydraulic-gradient component in a given direction or plane is often sufficient. Water-table contours are convenient for showing the direction of lateral water flow. Profile-flow patterns may be constructed from hydraulic-head measurements to show both horoizontal and vertical hydraulic-head distribution and direction of flow in the plane of the profile. Flow is normal to equal hydraulic-head surfaces†. The line formed at the intersection of an equal hydraulic-head surface with the water table is a water-table contour line. Fig. 1 shows a profile flow pattern in the vicinity of an open drain and illustrates the use of piezometers in evaluating flow systems. From a number of points of known hydraulic head, indicated by circles which show the location of the open end of piezometers, lines connecting points of equal hydraulic head are drawn. The direction of the flow component in the plane of the profile is normal to the equal hydraulic-head lines as indicated by the arrows and in this case is upward from an artesian source below. The depression of the lines of equal hydraulic head around the drain show that the drain is intercepting flow from below, but to a limited extent. At distances less than 30 ft on either side of the drain, flow is essentially vertical. Water is being removed at the soil surface by evaporation and transpiration resulting in the accumulation of salts in the surface from saline ground waters, and in this instance showing that open drains are not effective. This illustrates the type of flow problem that can be evaluated by the use of piezometers. Other flow problems for which piezometers are useful include perched or semiperched water-table conditions, sidehill seeps, flow from irrigation canals, etc.

SUMMARY

The factors that influence drainage design in irrigated areas may be grouped under three headings: (*a*) drainage requirements, (*b*) water-transmission properties of soils, (*c*) boundary conditions.

Drainage requirements include both the adequacy of drainage and the quantity of water to be drained. The two factors which may be varied or altered in the design of drainage systems are (*a*) the quantity of water to be drained and (*b*) the boundary conditions. The quantity of water to be drained is subject to a certain amount of control through improvements in irrigation distribution and application efficiencies and other water-conservation measures. Drainage needs may be materially reduced by the use of preventive measures that eliminate or reduce sources of excess water.

Boundary conditions are constraints that govern the pattern of flow and are related to the installation of drainage facilities. The problem of drainage design consists of selection of type, placement and arrangement of drains, which constitute a part of the boundary conditions, to control flow in such a way as to meet drainage requirements.

Water-transmission properties of soils may not be varied by the designer but figure importantly in the design and functioning of a drainage system. Evaluation of water-transmission properties of soils is one of the most important parts of a drainage investigation.

Both laboratory and field methods are available for determining soil-water transmission properties. Field methods generally employ larger samples and in most cases have greater utility for drainage design because the field determination is made for the soil in place.

The piezometer technique of determining subsoil stratigraphy and appraising ground-water flow conditions is an effective and inexpensive method that is being used in irrigated areas for drainage appraisal.

†Equal hydraulic-head lines on a profile section represent the intersection of equal hydraulic-head surfaces with the plane of the profile. Stream flow lines, i.e., average specific discharge lines, are orthogonal to equal hydraulic-head surfaces in isotropic soils. To illustrate direction of flow by graphical means it is desirable to use equal horizontal and vertical scales for plotting profile-flow patterns. If different scales are used the orthogonal relation between flow and equal hydraulic-head lines is altered. It has been shown by Casagrande (1) and others that problems involving soil anisotrophy can be treated by the use of scale distortion to transform an amsotropic to an isotropic system.

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The Evolution of Farm Implements and Machines

By Eugene G. McKibben
FELLOW ASAE

MORE changes have occurred in rural life and agricultural production during the past hundred years than in all previous time. The increasing application of engineering has been one of the fundamental factors. Electric lights, running water, refrigeration, motor transportation, milking machines, and most of present-day planting, harvesting, and processing machines were unknown on American farms in 1852.

It is indeed difficult for the present generation of 4-H club members to visualize a farm home where the tallow candle was the usual form of artificial light and where so far as the water supply for the farm kitchen was concerned, the only running was that done by the overworked farm wife or the children whose daily chore it was to replenish this water supply. Although machines designed to use animal power for a great variety of farm operations were beginning to appear, all farm operations, except seedbed preparation and part of the cultivation and transportation, were still hand operations on most farms.

As late as 1857 when Governor Bingham spoke at the dedication of Michigan Agricultural College, he saw fit to praise "the light and easy cradle, the handsomely turned three-tined pitchfork, light, bright hoe and hand rake" used by Michigan farmers in contrast to cruder tools used by farmers in less progressive parts of the country.

The remarkable evolution of farm implements and machines, including the farm tractor, has been a widespread phenomenon of the past century. The essential elements of this evolution, which has attained its greatest development here in the United States, are (1) the substitution of first animal power and later mechanical power for human labor for more and more of the arduous and tedious tasks inherent in agriculture and (2) the invention and perfection of devices and machines for the effective and efficient application of these non-human forms of energy.

More than 4 million tractors are in use on American farms and the manufacture of tractors and implements has grown to be a 2-billion-dollar industry. This development has displaced 20 million work animals and released for human use a 100 million cropland-equivalent acres which is about one-fifth of the total now available in the United States.

An address before the meeting of the American Society of Agricultural Engineers held in conjunction with the Centennial of Engineering Convocation at Chicago, September, 1952.

The author—EUGENE G. MCKIBBEN—is director of agricultural engineering research (BPISAE), U.S. Department of Agriculture.

The evolution of farm implements and machines in America has been one of the great phenomenons of the past century. It resulted in substituting first animal power and later mechanical power for human labor, which in addition to reducing drudgery also greatly increased the output per worker

This evolution is the most significant change in American agriculture. It has placed farming on a par with other occupations and industries. It is no longer necessary for farm workers to labor from dawn to dark. The labor of women and children is no longer required.

This evolution has not only reduced the fatigue and boredom of farm work; it has greatly increased the output per worker. As a result a smaller and smaller proportion of the total labor force has been needed to achieve an ever-increasing agricultural production. A hundred years ago about two out of three of our national labor force were farm workers. Today the ratio is only about one to six. Of course, some of this increased productivity must be credited to improvements in other phases of agricultural technology, such as better varieties, more effective use of fertilizer and improved cultural practices. The major factor, however, has been the increased utilization of non-human energy and of more effective machines and implements.

How important to society is this evolution of farm machines and implements? For the common man, for all men of good will, it is one of the outstanding events of history. It has removed the necessity for a peasant or serf class, a class exemplified by Millet's well-known painting and Markham's poem "the man with the hoe." It has released from the absolutely necessary occupation of agriculture the labor required for the less necessary but highly desirable production of a great variety of goods and services. These goods and services have resulted in a continuous rise in the general standard of living, to the highest yet attained. Because of this evolution it is possible now for all men to enjoy the benefits of citizenship in a cultured civilization. Admittedly our farm power and machinery technology is not the only requirement for a cultured civilized democracy, but it assuredly is one of the most essential requirements.

I am happy to have this occasion to pay tribute to the many thousands of Americans who have helped make possible the leading role which our nation has had in this accomplishment. A few have been adequately acclaimed as the creators of major inventions. Their names are well known to all who are in any way concerned with agriculture. I do not wish to detract from their well-earned fame. We must, however, acknowledge that none of these great ones worked alone. They were aided by cooperating and competing inventors, by

shop workers, engineers, business executives, salesmen, dealers, service men and pioneering farmers.

There is enough glory, however, to go around in spite of the disdainful views frequently expressed by highly trained technologists from other fields of endeavor. Admittedly, many farm machines appear crude and amateurish if studied as an isolated design exhibit, divorced from the physical and economic environment for which they were planned. Only those familar with agriculture have a real understanding of the difficult requirements which must be satisfied by a successful designer of farm implements.

Farm machines are used in the weather-conditioned factory of the great outdoors, where the temperature may be below freezing or well above 100 deg. These machines are subjected to rain, sleet, and snow. Instead of setting on a solid factory floor or moving over a smooth road, they must operate over uneven terrain through dust, sand, mud and stones. Instead of being supplied with uniform raw materials, as are production machines in factories, they must be designed to handle crop variations which are frequently well over 100 per cent.

Difficult as this physical environment is the economic conditions which farm machines and implements must meet are equally bad. It has been necessary to build them for a price. Their manufacture is an unprotected industry. They were used, until recently at least, in a completely competitive agriculture. In many cases they had a very low load factor, that is, very few hours of use per year or even for their life. For example, the grain binder, for many years a very important machine on many American farms, and a rather complex machine, was frequently used not more than 50 hours a year. This would be 2000 hours, or only 200 ten-hour days for a 20-year life.

Another result of this low load factor is operation by relatively unskilled operators. In contrast with the industrial worker who may operate only one kind of machine many hundreds of hours a year for several years, most farm workers must operate several distinctly different machines each year and in many cases for only a few hours each year.

HOW HAVE THE MANY ADVANCES IN FARM MECHANIZATION BEEN MADE?

How have these advances in the mechanization of farming been made? Has this accomplishment been achieved as the result of a few flashes of creative genius by a small number of great inventors? Many students of invention believe not. According to the book "Sociology of Invention" by S. C. Gilfillan, "An invention is an evolution, rather than a series of creations, and much resembles a biologic process, because it has a basic kinship with this, through innate human mentality."

Still quoting Gilfillan, "Is the biologic analogy anything more than an analogy? Yes, the ship or any invention is a biologic organ, in the same sense that a bird's nest is, if not a snail shell. Each is something made by a living creature, in order to meet the needs of his life, and it has grown up, evolved, along with the fleshy parts of him, by long process of mutual adaptation. The young birds have become so delicate that they cannot live without a nest; the nest has become so well built that it strongly promotes the survival of its bird, it has become almost as much a part of him as his bill and feathers. As the apes use sticks and stones, so

Typical of the evolution that has taken place in 100 years in the mechanics of harvesting the small grain crop, beginning with the sickle or cradle and human labor, is this Massey-Harris self-propelled grain combine operated by a single individual and replacing many additional workers

primeval man used chipped stones, and later evolving man has used ever more of tools, ships, and all inventions. They have so intensified and multiplied his life that he lives grandly and long, and has spread over almost every land and into the very waters and air. . . . Always his tools, his inventions, are essential parts of his biologic life."

Paraphrasing another statement by Gilfillan, the invention of a farm implement is essentially a complex of most diverse elements—a design for the machine invented, the constituent materials of which it is made, a method of building it, a process for which it is used, the principles of science needed to build or use it, the raw materials on which it is used, accumulated capital such as an improved farm on which it is used, its operating crew with their skills, ideas and limitations, financial backing for its construction and use, its purpose and use in conjunction with other sides of civilization and its popular evaluation. Most of these parts in turn have their separately variable elements. A change in any one of the elements of the complex will alter, stimulate, depress or quite inhibit the whole.

The time schedule for many of our farm machines also indicates a process of evolution rather than one of revolution. The first trial of a combine harvester-thresher was made in Michigan in 1835, only four years after McCormick first demonstrated his reaper in Virginia. The times, however, were not ready for such a machine in the Midwest. It was over ninety years later (1927) before the combine returned to Michigan where it is now a widely accepted machine.

The basic principles of the snapping-roll corn picker were patented in 1874. It was sixty years later, in the 1930's, before the corn picker began to have general acceptance. The first patent on a device to pick cotton was granted in 1850. It is now over a hundred years and more than a thousand patents later and cotton pickers have only recently attained general acceptance.

Assuming our premise that our present state of farm mechanization is the result of evolution, why did this evolution attain its maximum rate here in the United States dur-

ing the past century? No one, of course, can give a positive answer to this question, but it appears that this historic evolution is the result of a combination of favorable circumstances, a combination unique in the world's history and one which probably will not appear again.

Some of the elements of this combination are as follows:

1 A stable, equitable government over a large area.

2 A government which favored initiative and free enterprise without internal trade barriers.

3 A publicly supported system of compulsory education.

4 The psychology of increased production developed by a people who had settled in a new land, to conquer it, develop it, and make it their home.

5 The psychology of change which became intensified as the more adventurous of each generation moved west to pioneer a new frontier.

6 A rapidly increasing population occupying new lands allowed the introduction of new machines and new methods without the necessity for discarding the old.

7 A surplus of clear, level land well-suited to mechanization.

8 The absence of a peasant or serf class in much of the area.

9 A shortage of agricultural labor, at least only a very infrequent surplus of labor. Under such conditions great emphasis was placed on production per man.

10 Three all-out wars which produced severe labor shortages. The Civil War established the reaper, World War I the tractor and combine harvester, and World War II the cotton picker.

11 A rapidly expanding and effective industrial development which absorbed the labor released by farm mechanization and which supplied many of the elements needed to perfect and produce new farm machines and implements as they evolved.

12 A remarkable development of transportation — railroads, high-quality hard-surfaced highways with trucks, buses and automobiles and the airplane.

13 Vastly more effective manufacturing methods for making agricultural implements such as automatic precision machine tools and well-managed assembly lines.

14 Lower cost methods of producing steel and other metals.

EVOLUTION OF THE INTERNAL-COMBUSTION ENGINE

15 The gas welding and cutting torch and electric arc welding. These processes have been, and are, of great importance through the life cycle of farm machines from manufacture, through adaptation and maintenance to the final scrapping at the end of a useful life.

16 The evolution of the internal-combustion engine and the coordinate development of fuels and lubricants for this engine.

17 The introduction of pressure-gun lubrication.

18 The development of simple, efficient electric motors. These are doing for farmstead labor what the internal-combustion engine did for farm field labor.

19 The development of low-cost high-quality anti-friction bearings.

20 The perfecting of enclosures for transmissions and effective seals for protruding shafts.

21 The evolution of the airplane which has become an important link in the chain of farm mechanization.

22 The evolution of the pneumatic tire which was developed for road transportation, but is currently an important element of many farm machines.

23 Hydraulic control systems, originally developed for industrial transportation and construction equipment.

24 Outstanding advances in the biological sciences of agriculture. Plant breeders have greatly aided mechanization by producing varieties better suited to mechanical harvesting — grain sorghums of uniform growth, shatterproof small grains, hybrid corn, and stormproof cotton are examples.

25 A progressive agricultural chemical industry which has supplied increasingly effective chemicals for fertilizing; for disease, insect, and weed control; for growth control such as defoliation for cotton harvest or fruit retention for a better apple harvest. The highly intriguing possibility of a practical conditioner for aggregating impervious soils is the newest promise.

26 Improved processing plants which enable these plants to handle mechanically harvested products. Sugar mills and cotton gins are examples.

There may be other important elements which have made an important contribution to the remarkable evolution of farm machines and implements during the past century, but these twenty-six are enough to indicate the great diversity of the forces which have influenced this evolution. While we could have had important developments in the field of farm mechanization without all of these elements, if any one had not been present the present status would be materially different.

WHAT IS THE FUTURE OF MECHANIZED AGRICULTURE?

What of the future? A society based on a mechanized agriculture has some points of vulnerability. A sudden extensive and extended dislocation of our supply of liquid fuel would be disastrous. Surely coke, coal or wood-chip gas producers can be used on farm tractors, but some of us might be hungry before this type of equipment could be supplied for four million farm tractors. This would be particularly true if the same causes which had disrupted our tractor fuel supply had also dislocated manufacturing facilities.

Since our mechanized agriculture is dependent on specialization and an effective exchange economy, it is absolutely dependent on efficient transportation, adequate and honest processing industries, effective and reliable merchandising organizations, a sound money program, and last, but not least, a stable and equitable government. If any of these elements fail us, we will be in serious trouble. If such trouble should occur the basic cause will be a social failure rather than a mechanical one. Technology has the continuing task of aiding the evolution of farm implements and machines but the final answer depends on effective sociology. It is the duty and privilege of every engineer to accept the responsibilities of citizenship; to do his part in developing and maintaining a society which will enable the average citizen to reap the maximum benefits attainable from the almost limitless possibilities of physical and biological technology.

Compaction of Irrigated Soils by Tractors

By L. D. Doneen and D. W. Henderson

SOIL compaction has long been recognized as "plow sole" in orchards and old grain lands. Recently a similar problem has become serious enough in field crops to cause concern (1)*, especially on irrigated lands where yields depend on adequate water penetration. Usually the first symptom is the slow penetration of water into the soil. In a survey, the authors have noted that soil compaction may occur to a depth of 20 in and, in some cases, limits root development. Reduced root development usually results in a striking reduction in the growth of the plant. It is difficult to separate the effects of retarded root growth and inadequate water supply from restricted water penetration.

A dense layer about 18 in deep under the cultivated surface soil for Yolo clay loam is illustrated in Fig. 1. Corn roots were unable to penetrate the compact subsoil with an apparent density of 1.5 g per cu cm. This soil has a normal density of 1.3 g per cu cm. In a cotton field on Hesperia sandy loam, half of the field was chiseled to a depth of 20 in and yielded two bales of cotton. The other half yielded one-half bale and had considerable growth of water grass. This was due to the poor penetration of irrigation water, which stood in the furrows for long periods after each irrigation.

The diagnosis of poor water penetration due to soil compaction is difficult since low infiltration rates are also caused by excessive quantities of adsorbed sodium and by high clay content of soils. To facilitate the securing of undisturbed soil samples, the senior author developed a special core sampler which can be used for soil density studies (Fig. 2). The sampler utilizes a paraffined cylindrical drug carton for the inner liner and sample container. It has an advantage over the metal container described by Van Doren and Kingebiel (2) and others, as single samples can be taken to a depth of 7½ in. These samples can be used for infiltration rates on essentially undisturbed soil and cut into as many different depth increments as desired for density determinations.

It has been found that apparent density of the soil is not a sensitive criterion for compaction (1). Laboratory experiments designed to correlate soil density with infiltration rate show that at low apparent densities a small increase in the density results in a marked decrease in infiltration rate, while at high densities a relatively large increase in density causes only a slight further reduction in infiltration rate. Similar data have been obtained with field structure samples. The results of these experiments agree with data published by Bodman (3) and are in accord with the concept of Baver (4) and others that the larger pores of the soil are most important in rapid conduction of water. Soil density is a measure of total porosity, but does not give the size distribution of the pores. Furthermore, soil density may vary within a small area in the field. If density measurements are to be useful for an indication of soil compaction, large numbers of samples must be taken and a similar area known to be free of compaction must be available for comparison.

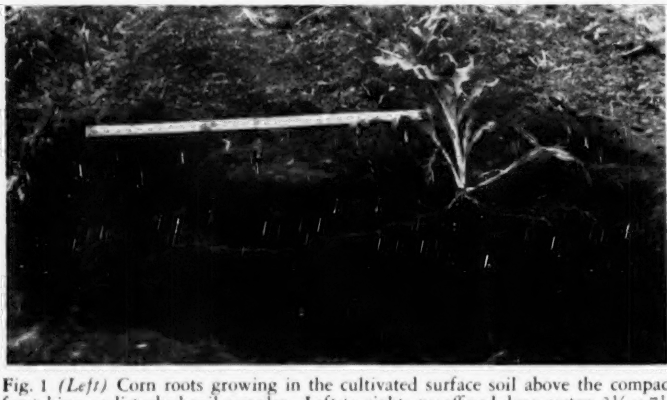
Probably a better criterion of compaction is the water infiltration rate determined in the field or on undisturbed core samples. If excessive adsorbed sodium is suspected, infiltration tests can be made with a water high in calcium, such as a gypsum solution. In a larger number of cases, observation of the soil in place will show whether or not it is compacted, especially if it occurs in a layer and uncompacted soil lies above or below it. In some cases, root development of crop plants in the field offers a clue.

A survey of the problem by the authors (1) has led to the conclusion that compaction is widespread in California and apparently a result of working the land with tractors and other heavy farm equipment. Since many tillage operations must be fitted into crowded farm plans, knowing when such work can be performed with a minimum of compaction is of vital importance. As a first step in this direction, an experiment was carried out to determine the effect of passage of a tractor over the soil at various intervals of time after irrigation.

This paper was presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Davis, Calif., January, 1952.

The authors — L. D. DONEEN and D. W. HENDERSON — are, respectively, associate irrigation agronomist and assistant irrigationist, University of California (Davis).

*Numbers in parentheses refer to the appended references.



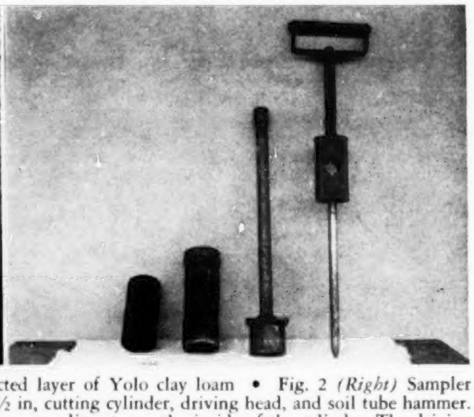


Fig. 1 *(Left)* Corn roots growing in the cultivated surface soil above the compacted layer of Yolo clay loam • Fig. 2 *(Right)* Sampler for taking undisturbed soil samples. Left to right: paraffined drug carton 3½ x 7½ in, cutting cylinder, driving head, and soil tube hammer. The paraffined carton slips inside the cutting cylinder which has a cutting head the same diameter as the inside of the cylinder. The driving head is machined to fit inside the cutting cylinder to hold the carton in place and form a rigid joint. The joint on the soil hammer fits into the pipe forming the top of the driving head

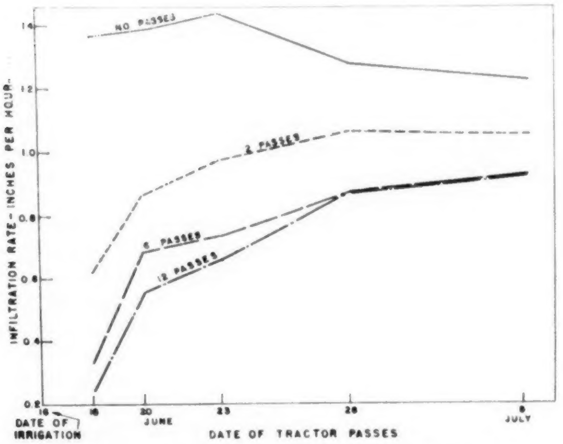


Fig. 3 Infiltration rate in tracks of a wheel tractor passing over the soil at various dates after irrigation. "Passes" means the number of times the tractor moved over the plot in the same tracks

Methods and Procedure. The experiment was carried out on Hesperia sandy loam at the U.S. Cotton Station near Shafter, Calif. This location was selected because soil compaction due to tillage frequently occurs in this area on Hesperia and similar soil types. A large percentage of tillage operations are performed during seedbed preparation and the cultivation of young row crops, when drying of the soil occurs largely by evaporation. These conditions were simulated by carrying out the experiment on fallow land in late June when evaporation from the soil surface was rapid.

The tractor used was a large row-crop type equipped with 11-38 rear tires and two 5:50-16 front tires placed close together. Each rear wheel was equipped with a 300-lb weight and the rear tires were partly filled with water. The total weight of tractor and driver was 5200 lb, of which approximately 80 per cent was borne by the rear wheels. There was no draft on the tractor when it was passed over the experimental plots.

The entire experimental area was irrigated on the afternoon of June 16, and the tractor was driven over different portions of plots 2, 6, and 12 times (passes) at successive later dates — June 18, 20, 23, 28, and July 5. On the dates of tractor passes soil moisture samples were taken in 3-in increments to a depth of 12 in and in 6-in depths from 12 to 24 in.

On July 22 the plots were again irrigated and infiltration rates were determined the following two days, July 23 and 24. These studies were made on a moist soil (field capacity) which eliminates some of the variability occurring naturally in dry soils. Infiltration rates were determined by forcing a 6-in metal cylinder into the soil, filling it with water, and measuring its subsidence for 3½ hr with a Lory hook gage. The cylinders were placed at three points in each track, including those made by the front wheels, and at nine points outside the tracks in each plot to serve as checks. A plot consisted of the area used for passing the tractor over the soil 2, 6, and 12 times on a given date. Each plot was duplicated. Thus a total of 12 infiltration tests were made in the tracks of the rear wheels of the tractor, 6 in the tracks of the front wheels, and 18 tests outside of the tracks for checks.

Results. Examination of the data indicated the infiltration rates were the same in front and rear wheel tracks.

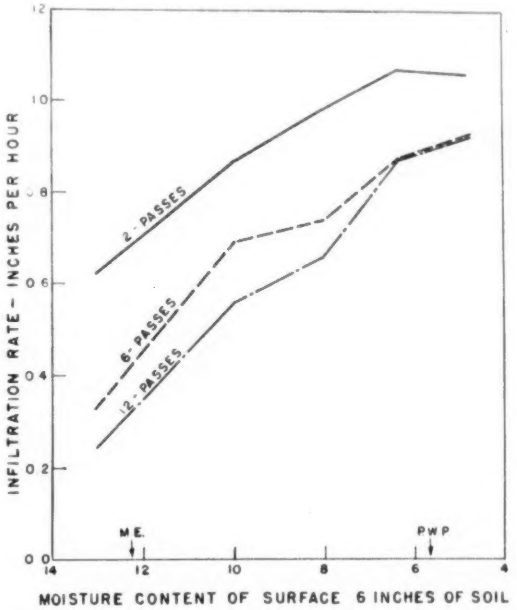


Fig. 4 Infiltration rates in tractor tracks in relation to soil moisture content at the time of tractor passes

Apparently the smaller bearing surface of the front wheels resulted in pressures comparable to that exerted by the rear wheels. Infiltration rates for front and rear wheel tracks were combined, giving an average of 18 tests for the tractor tracks for each date and series of passes.

In Fig. 3 the over-all average infiltration rate for each treatment is plotted against time after irrigation when the tractor passes were made. The data indicate that the reduction in rate of water infiltration is governed by the number of passes made by the tractor. Even two passes soon after irrigation markedly reduced the infiltration rate. The data also show that little is gained by delaying tillage operations more than seven days after irrigation under these soil and climatic conditions, even though there is a significant reduction in infiltration rate after 19 days for all treatments.

There is no significant difference in the effects of six and 12 passes at any date, although both these treatments resulted in significantly greater reductions than two passes throughout the experimental period.

The relationship between the infiltration rate and the soil moisture content at the time of the tractor passes is presented in Fig. 4. The moisture content of the surface 6 in was used because this was the depth in which surface evaporation occurred. Below this depth, the soil moisture was near field capacity. The relationship is approximately linear from a moisture content slightly above the moisture equivalent to a moisture content approximating the wilting percentage — a wide range. It should be noted that these data are in agreement with soil mechanics literature which indicates that compression of a soil under a given load increases with increasing moisture content up to a point somewhat below saturation of the compressed soil. The moisture content of maximum compaction was not approached in this experiment. These curves likewise indicate that the reason for the relatively small changes in infiltration rate occurring near the end of the *(Continued on page 102)*

Application of the Soil Moisture Characteristic Curve

By G. J. Decker

THE soil moisture characteristic curve will enable an irrigator to apply the water more efficiently. From the curve he can find the per cent of moisture that is retained in the soil at field capacity and at the permanent wilting range. From these two values the amount of moisture available to plants in the soil can be figured.

The curve is obtained by plotting values obtained by making tests with the pressure-membrane apparatus, and it is used in other studies of the soil and its moisture system.

Irrigation development has reached a stage where longer canals and larger reservoirs must be built and more expensive and larger structures used before 50 per cent of the remaining irrigable area of the United States can be irrigated. This will cause the water to cost more and therefore call for efficient irrigation.

Engineers will be called upon to make estimates as to the practicability of the proposed projects. One of the important items an engineer must determine before he makes his estimate is the amount of water available to plants that can be stored in the soil. In order to find the amount of water available to plants that can be stored in the soil, the field capacity and permanent wilting range of the soil must be found. These values can also be used by the irrigator in planning efficient irrigation.

The object of this paper is to show how to find the per cent of moisture in a soil at field capacity and at the permanent wilting range and how to use them in finding the amount of water available to plants that can be stored in the soil.

From the soil moisture characteristic curve an engineer designing an irrigation system can obtain helpful information other than the field capacity and permanent wilting range.

Literature. Several researchers have done outstanding work in finding the per cent of moisture in a soil at the field capacity and at the permanent wilting range. L. A. Richards and L. R. Weaver have done the most recent work on obtaining the soil moisture characteristic curve.

The pressure-membrane apparatus was designed by L. A. Richards. The pressure-membrane is the best method at present used to obtain the soil moisture characteristic curve.

Obtaining and Use of the Curve. It has been shown by several investigators that, when the rate of downward movement of soil moisture has become negligible the amount of water left in a soil after a rain or after irrigating is the maximum amount that can be used by plants. This is called field capacity. It has also been shown that all plants are able to dry the soil to about the same moisture content before wilting. This moisture content is spoken of as the permanent wilting percentage. These two moisture contents are characteristic of a given soil and represent, respectively, the upper and lower limits of moisture available to plants that can be stored in the soil. After the field capacity and the wilting point of a soil have been found, the engineer can use these values in making his estimate of how much water will be needed for the project.

The usefulness of the field capacity and the permanent wilting range to an irrigation project, coupled with the difficulty of their determination, has led to the search for unique relationships which may exist between these values and some soil characteristic which can be readily measured in the laboratory. To get this problem down to local level soil was obtained from local irrigation farms and brought to the laboratory to be subjected to a test with the pressure-membrane apparatus. The object of the test was to find the amount of water the different soils will hold. The soils used for the test for this paper were obtained from the Austin irrigation district at Altus, Okla.

The pressure-membrane apparatus used and the procedure followed were the same as described by L. A. Richards (1)*. The pressure-membrane apparatus consists of a chamber and a source of pressure.

The chamber has a bottom and a top plate. The bottom and top plates are made from a steel casting with a tensile strength of 70,000 psi. The bottom plate is machined and is fitted with tripod legs. It also has a small hole in the center to allow water to escape. The upper surface of the bottom plate is fitted with a 100-mesh screen. The screen supplies a uniform support for the cellulose sausage-casing membrane, and still allows the water that passes through the membrane to move freely toward the outflow tube. For efficient operation the membrane should be replaced at least every third run. The soil samples are placed on the membrane in rubber rings 2 in in diameter and ⅜ in high.

The vertical wall for the extraction chamber is formed by a cylinder ½ in high made from a brass strip.

A gasket is required between the cylinder and the cellulose membrane. A gasket made from an innertube proved very satisfactory.

The top plate completes the soil chamber. The top plate is machined differently than the bottom plate. The gas seal at the top plate is made by a thin sheet copper liner. A

*Numbers in parentheses refer to the appended references.

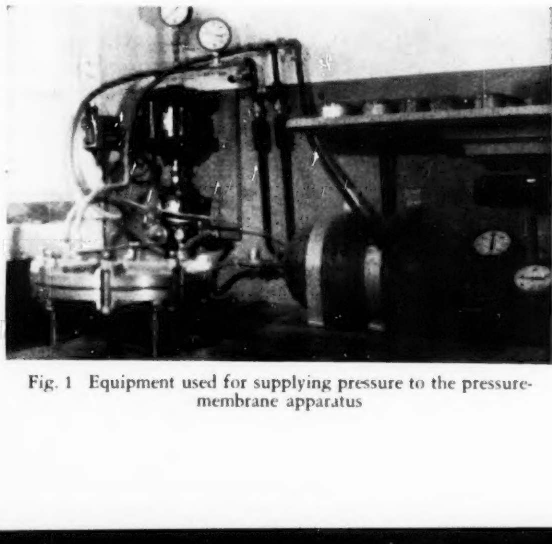


Fig. 1 Equipment used for supplying pressure to the pressure-membrane apparatus

This paper was entered in the competition for the 1952 Student Paper Awards sponsored by the American Society of Agricultural Engineers.

The author—G. J. DECKER—is a 1952 agricultural engineering graduate of the Oklahoma A. & M. College.

ACKNOWLEDGMENT: The author acknowledges the assistance of James E. Garton in connection with the project reported in this paper.

rubber diaphragm is fitted to the lower surface of the top plate. Pressure required to operate the diaphragm for holding the soil samples against the membrane is obtained from a differential mercury manometer. The top plate is bolted to the bottom plate with eight bolts.

When pressure is admitted into the chamber a condition is created such that the membrane extracts moisture from the soil. The amount of moisture retained in a soil depends on the amount of pressure in the chamber and reaches equilibrium after a short time at that pressure. The higher the pressure, the more moisture is removed.

The equipment used for supplying the pressure (Fig. 1) was a Cornelius air compressor capable of developing 1,500 psi, and run by a ⅓-hp motor, a non-shatterable pressure tank, a pressure-regulator switch, mercury manometer, valves and gages. Pressure of 300 psi was maintained in the tank.

For the test representative subsamples, from undisturbed soil samples, that passed through a 2-mm round-hole sieve were used. Three samples of each soil were placed on the membrane in the rubber rings. The samples were soaked at least six hours by having an excess of water on the membrane. At the completion of the wetting process the excess water was removed from the membrane with a pipet. The chamber was then closed by bolting the top plate to the bottom plate.

Pressure was then admitted to the soil chamber at a predetermined amount by regulating valves on the pressure system. This pressure was maintained for 48 hr or until the soil had reached equilibrium. After the soil reached equilibrium the top plate was removed and the soil sample was then placed in soil moisture cans, weighed, and dryed at 105 C for 24 hr.

To obtain the per cent of soil moisture versus tension curve (soil moisture characteristic curve) a sample of soil is subjected to a pressure difference across a porous wall or membrane. This pressure difference is usually called soil-moisture tension and is commonly expressed in standard atmospheres. Tension expressed in atmospheres is plotted against the per cent of moisture retained in the soil at that tension (Fig. 2).

The attraction of soil for water arises from force fields associated with interface boundaries in the soil-moisture system and so soil-moisture tension may be taken as a measure of this surface force action. The moisture content of a soil on a porous plate or membrane will attain a steady value if a constant tension is maintained across the plate or membrane (2).

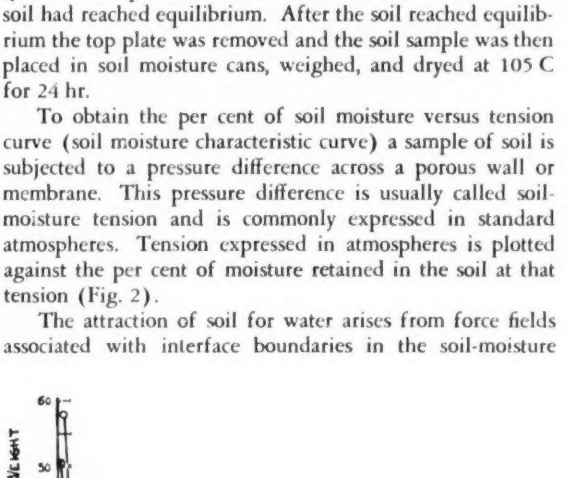


Fig. 2 Soil moisture characteristic curves: 1A, silty loam soil; 1B, loamy soil; 1C, sandy loam soil

It is evident that no single moisture tension will bring all soils to the same moisture content. However, since several investigators have found that the soil moisture retained against a tension of ⅓ atmosphere closely approximated the field capacity of most soils and that 15 atmospheres tension brought most soils to a moisture content that lies in the wilting range, these tensions were used. The difference between these two points is the per cent of moisture, based on dry-weight basis, that is available for plant growth. The per cent of available moisture based on dry-weight basis multiplied by the apparent specific gravity of the soil will give a per cent of moisture on the volume percentage basis. The amount of water (expressed in inches) a particular soil will hold per foot can be found by using the equation, $d = P_{ac}/100 \times A_s \times D$. P_{ac} = the amount of available moisture for plants based on the volume basis; A_s = the apparent specific gravity of the soil, and $D = 12$ in, or the depth of soil in inches. Although the results from this test and the equation are not exact, they are close enough for practical purposes and application.

When an irrigation farmer knows the moisture content of his soil at field capacity and at the permanent wilting range, as found by the use of the pressure-membrane process, he can figure the available water capacity of his soil. By keeping track of the per cent of moisture in his soil, he can determine when to apply water. When this moisture per cent reaches the moisture per cent at the permanent wilting range, it is time to irrigate. The per cent of moisture found in the soil before time to irrigate subtracted from the per cent of moisture at field capacity gives P_{ac} in the above equation. By using the above equation the depth of water to apply, excluding losses, can be figured.

Finding the per cent of moisture in a soil at field capacity and at the permanent wilting range is not the only use of the pressure-membrane apparatus.

The curve, obtained by relating negative pressure, or soil moisture tension, to moisture content (soil moisture characteristic curve), is being used in relating the soil-moisture system with other properties of the soil. By studying the soil moisture characteristic curve of a soil, the pore-size distribution can be related to the moisture release process. The pressure deficiency p required to maintain soil at a given moisture content is the pressure difference between the two sides of the air-water interface within the soil pores. If r is the radius of curvature of a spherical interface in equilibrium at this pressure difference, then $p = 2s/r$, where s is the surface tension. Pores into which the interface may retreat via channels of radius greater than r will, at this pressure deficiency, be emptied of all water except that which remains in nocks and crannies in such small quantities as can be contained within an interface of smaller radius of curvature (3).

Richards and Weaver have found that the soil moisture characteristic curve can be used to identify the type of colloid properties of a soil (2). The shape of the soil moisture characteristic curve gives an indication of the texture of the soil. Clay soils have a higher moisture content at field capacity than sandy soils. They also have a higher moisture content at the permanent wilting *(Continued on page 102)*

Soil Conditioners in Soil Conservation

By C. S. Slater

INTEREST in soil conditioners evolves from a simple fact. When they are applied properly to soil they bind the separate grains into waterstable crumbs that resemble closely the natural aggregates of ideally structured soils. This benefits the soil in a number of ways. The effects are not marked on soils that are well aggregated to begin with, but the aggregation produced by conditioners causes extensive physical changes in poorly structured soil. Such soil becomes friable, is more easily worked and maintains better tilth. Infiltration, permeability, and aeration are improved in the treated soil because of an increased number of large capillary pores. The soil becomes better adapted to root and plant growth. However, only the treated soil is affected. Conditioners are relatively immobile after they have reacted with the soil.

Because the new soil conditioners cause aggregation, they have been called soil-aggregating chemicals, or soil aggregants. The terms fit and I shall use them in this paper to identify conditioners based on such chemicals as vinyl acetate maleic acid and hydrolysed polyacrylonitrile. The more inclusive term, soil conditioners, will be applied to various materials that may be used to modify the physical properties of soil in any of several ways.

I want to relate soil conditioners in this broader sense to their possible conservation uses. In this way, perhaps, we can determine more accurately the true value of the new soil aggregants.

It is not entirely facetious to list agricultural engineers among the more effective soil conditioners, because of their activity in furthering developments in tillage, land levelling, drainage and erosion control. The maintenance of a suitable water content in the soil and control of runoff are certainly important factors in conditioning soil for continuous agricultural production. The importance of mechanically conditioning the soil with tillage is attested annually in the efforts expended to plow, harrow and pack it in preparation for crops.

When the tillage operations are completed, the mechanical condition of the soil should approximate an ideal tilth for germination and crop growth. Whether the soil stays in that condition long enough to grow and ripen a crop depends on soil properties over which the engineer has not had control. If the soil aggregates are water stable, the crumbly, friable condition produced by tillage will maintain itself against the slaking action of heavy rain and irrigation water. If not, the soil slakes and the effects of tillage are lost. If saturating rain comes early in the growing season on soil that is not water stable, the effect is roughly that of attempting to grow crops without any preparation of the soil.

Lack of control over the subsequent behavior of the soil has made it difficult to determine just what constitutes adequate mechanical soil preparation. From the conservation standpoint tillage should be kept at a minimum compatible with good crop yields. I submit that one of the immediate uses of the new soil aggregants will be the control of soil quality in experimental investigations of tillage practices.

Organic matter is a second and more commonplace soil conditioner that has many conservation uses. In the form of crop residues on the soil surface it breaks the erosive force of falling rain, prevents puddling of the soil surface, maintains infiltration, assists in the establishment of new seedings and affords protection to the soil from repeated freezing and thawing. Mixed with the soil in some quantity its physical body promotes a desirable heterogeneity in soil structure and chemical composition. It becomes a true soil aggregant through the action of fungi and bacteria as it decays.

The by-products of organic matter decomposition and the granulating action of roots and earthworms probing through the soil constitute a natural method of developing or restoring a desirable crumb structure to soils. With all due respect to chemical aggregants, there is no better way of promoting a water-stable aggregated soil under general conditions of agriculture than to maintain fertility and return the land periodically to deep-rooted sod crops.

The new soil aggregants need not compete with grass and legumes in conservation uses. Rather, their use should be considered as supplemental to established conservation practices. How they will be used is subject to speculation because much remains to be learned with respect to practical application and the properties of specific aggregants.

We can, however, anticipate certain uses, based on their common property of aggregating soil. Weeks and Colter showed that surface soil can be stabilized satisfactorily against the erosive action of rainfall by treating the surface with certain aggregants (5)*. A rate of application of 1 lb or less per 100 sq ft provided satisfactory protection in most cases. Runoff was reduced by the treatment. Results like these suggest that soil aggregants can serve as a temporary means of controlling erosion on bare soil until vegetation can become established. In cases where vegetation must be established and mulching material is difficult to obtain, or where high winds make mulching a particularly hazardous procedure, use of soil aggregants may ultimately supplement present mulching procedures.

Perhaps a word of caution should be inserted here. In two cases that have come to my attention, shallow applications of soil aggregants appeared to cause a drying effect on the soil surface that interfered with the germination of shallow-planted small seeds, in these cases, bluegrass and tobacco. Larger seeds, planted an inch or more deep, were not so affected. On a poor soil germination of larger seeds improved greatly following treatment.

Results obtained by Goodman (2) support those of Weeks and Colter. Goodman suggests that since silty soils are susceptible to frost heave and because aggregating chemicals bond the fine-grained particles into larger aggregates it seems advisable to study their effects in controlling frost action. He states that cut-and-fill sections will tolerate steeper slopes if treated with soil (Continued on page 100)

*Numbers in parentheses refer to the appended references.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1952, as a contribution of the Soil and Water and Power and Machinery Divisions.

The author—C. S. SLATER—is senior soil conservationist, Soil Conservation Service, U.S. Department of Agriculture.

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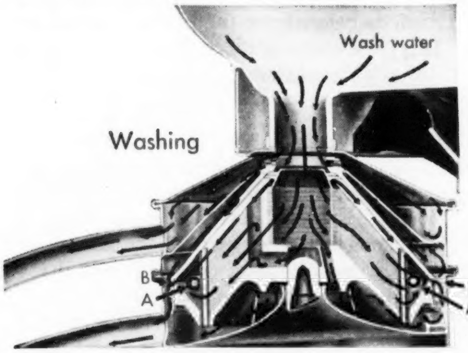
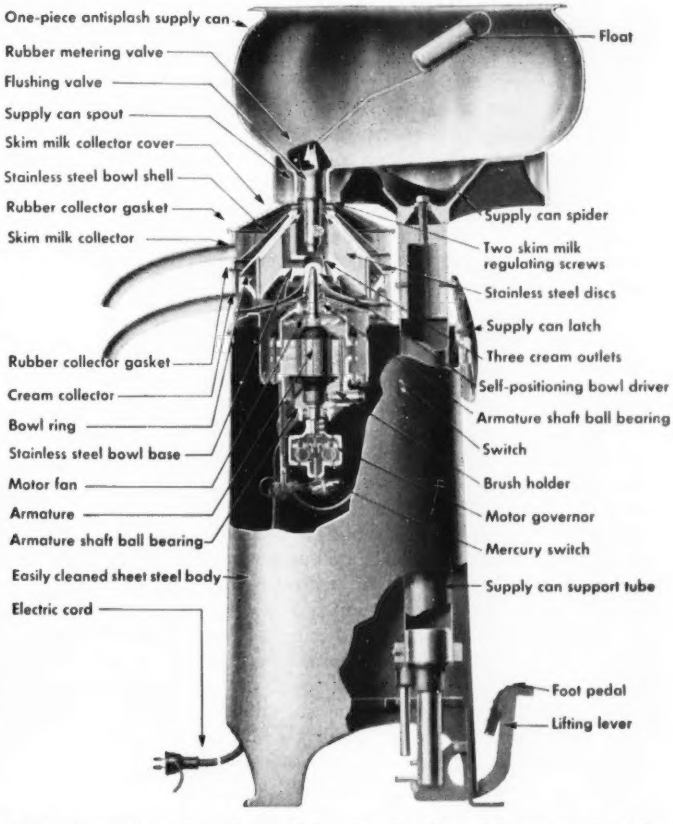


This cross-section shows the power washing action of the McCormick separator. As the separator speed is reduced for washing, the bowl ring (A) contracts to open the water escape holes (B) at the base of the bowl. With the flushing valve in the supply can removed, a large volume of water rushes into the bowl. Centrifugal action floods the water through the bowl and out the opened holes with a powerful washing force.



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Soil Conditioners

(Continued from page 98)

aggregants. He suggests also that the chemicals may prove effective as dust controllers, but this suggestion is somewhat at variance with unpublished results obtained by W. S. Chepil, at Manhattan, Kans., who found that under certain conditions where cloddiness was decreased by the treatment some of the aggregants increased wind erosion.

Aggregants may have a place in tile drainage. Drainage engineers recognize the importance of proper blinding, i.e., an earth fill of sod or other highly permeable soil immediately surrounding the tile. John G. Sutton, drainage section, U.S. Soil Conservation Service, proposes an experimental treatment of the entire backfill of tile drains with aggregating chemicals on soils that are slowly permeable. He recommends a trial of the treatment in depressions at locations where surface water collects. At such locations blind inlets of gravel, coarse sand, and corncobs are often used. These are not as effective as well-graded material, which is difficult to obtain in some locations. Under such circumstances the use of aggregating chemicals to form satisfactory backfill is worth trying.

OTHER CONSERVATION USES FOR AGGREGANTS

Imaginative thinking suggests other conservation uses for aggregants where the problems involve soil structural deficiencies. More intensive use of the best agricultural land may be possible if aggregation can be maintained by chemical means. This could relieve production pressure on land more susceptible to erosion and release it to longer rotations with a higher proportion of soil-conserving crops. Shallow soils could be deepened by subtillage and the use of soil aggregants to make them more productive and drought resistant. Terrace channels could be treated to improve the productivity of the exposed subsoil and lower its erodibility.

Vegetation may be established more surely on roadside banks, dams of farm ponds, airports, ammunition dumps and other sites where earth moving has exposed raw subsoil. Graded waterways sometimes present unusual difficulties where the combined effect of highly erodible unproductive soil and excess water render the establishment of vegetation exceedingly hazardous. In cases like these soil aggregants may prove a useful supplement to accepted agronomic and engineering measures.

I have labelled these proposals as imaginative thinking. The unpalatable truth is that at present prices of about a dollar a pound for soil aggregants and recommended applications of not less than several hundred to more than 1000 lb per acre, most of them must be labelled also as wishful thinking. However, some reduction in price can be anticipated and with it we can expect wider opportunities for the economic use of soil aggregants.

There are other soil conditioners deserving of mention. Some of them may be competitive with soil aggregants in offering temporary protection against soil erosion. Information is available in an article by Harold M. Smith (4) who tested the effect of asphalt sprays for erosionproofing exposed soil surfaces. He reports that two preparations of distinctly different type seemed quite satisfactory as substitutes for straw mulch. One was an asphalt emulsion sold under the trade name Terolas, the other a semisolid asphalt in a volatile carrier known as "asphalt mulch." They have advantages over mulch with respect to blowing and fire hazards. Plants from seedings made prior to the applications grew through the asphalt coating without difficulty and made excellent stands. Also, they came up earlier under asphalt than on check plantings. Absorption of heat and sealing in of moisture by the black asphalt appeared to produce better germination conditions for the seed.

Costs were estimated at from 5 to 8¢ per sq yd for the asphalt treatment, or from about $240 to $400 per acre.

Certain plastic and latex formulations also offer some promise as conditioners for the soil surface to retard erosion temporarily and seal in moisture and thus help to establish newly planted shrubs and aid in germinating small seeds.

The chemical reactions of lime, gypsum and sulphur applied to the soil result in physical effects that must be considered in any general discussion of soil conditioners. Lime, when applied to acid soils, has beneficial effects related to plant nutrition that are reflected ultimately in better soil structure. On saline and alkaline soils gypsum and sulphur react to release sodium from the soil exchange complex so that it can be leached more readily from the soil. In this process the soil colloid is rendered less disperse, and as a result the soil becomes more permeable and better adapted physically to crop growth. The flocculation of the soil colloids is an essential first step in the formation of a desirable soil structure.

The purposes served by lime, gypsum and sulphur are not apt to be affected greatly by the introduction of soil aggregants. They will continue to perform as soil conditioners where their combined chemical and physical reactions are required for soil improvement.

COMMON CHEMICALS AS SOIL CONDITIONERS

Other common chemicals, namely, the acid salts of iron and aluminum, have been used as soil conditioners. Their use in this country has been limited generally to highly specialized applications, but reports from Italy indicate the probability of wider uses of these elements in special formulations containing their salts and organic matter. "Flotal" is such a product. Flotal combines to some degree the flocculating effects of acids and the tri-valent ions with a subsequent cementing action through the precipitation of hydrated iron oxide. Thus its effect in conjunction with tillage is to make dense clays more friable and more permeable. Gasparini and Alinari (1) in Italy have reported substantial success in improving the physical condition of and crop production on heavy alkaline clays with applications of Flotal. Flotal may prove to be a useful addition to the list of soil conditioners already available on the American market. It is most apt to prove useful in the West where irrigation of alkaline soils presents the combined problems of infiltration, leaching, drainage, and iron chlorosis.

Any material that affects the structure or water relationships of soil offers possibilities of becoming a conditioner for specific conservation uses. Most conditioners aim at improving the soil in terms of crop growth or improved tilth and permeability. Others may find their use in rendering soils impermeable. In farm ponds and irrigation ditches impermeability becomes a desirable soil characteristic. It is obtained usually by mixing the correct proportions of sand and clay for the core fill, pond or canal lining, plus mechanical compaction. However, bentonite is used as a gelatinous inorganic material to stop seepage in structures of this sort. Holtan (3) points out (Continued on page 102)

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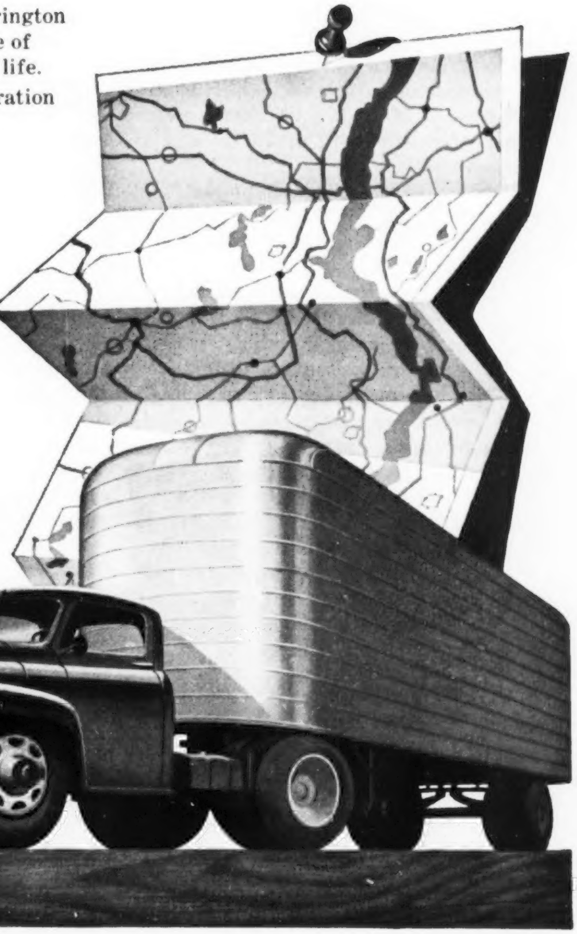

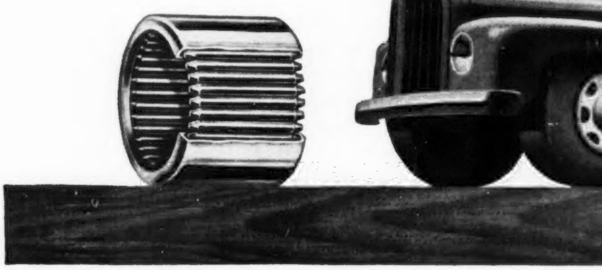

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Compaction of Irrigated Soils by Tractors

(Continued from page 95)

experimental period are caused by slow drying of the soil at that time. Core samples were taken with the sampler shown in Fig. 2 in four plots corresponding to the first four dates at which the tractor was passed over the soil. Volume weights of these cores and examination of the soil in the field indicated that the compression of soil by the tractor tires was apparently limited to a depth of about 7 in under the severest treatments (6 and 12 passes at 2 and 4 days after irrigation), and that the depth affected was somewhat less with the drier soil. However, neither method of determining the depth affected is sufficiently sensitive to indicate changes which would be relatively large as measured by water infiltration.

A survey of the compaction problem carried out by the authors (1), including the results of the experiment reported here, has led to the conclusion that there is no easy and rapid solution. The best approach seems to be a prevention of soil compaction through intelligent practices in soil management. The first step in such a program would be a delay in tillage until the soil is reasonably dry.

Had there been a load behind the tractor, compaction might have been more severe due to slippage of the wheels. Any soil-working equipment, such as a chisel, disk, or plow, would have partly destroyed the surface compaction and minimized the effects on infiltration. The authors believe that continually working wet land will cause a general compaction to 18 in or more in depth (1). However, under conditions similar to those of this experiment, the soil should not be tilled for as long as possible after wetting by rains or irrigation, and the tillage operations or number of passes over a field should be kept to a minimum.

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Soil Moisture Characteristic Curve

(Continued from page 97)

point. By working with the soil moisture characteristic curve the hydraulics of the soil-moisture system can be better understood.

RESULTS AND CONCLUSIONS

The curves (Fig. 2) obtained for this problem were similar to those obtained by other investigators.

The curve 1A shows that the particular soil used for that curve is better than the other two soils for irrigation on the basis of amount of available water it contains. The soil used for obtaining curve 1C contains the greatest per cent of sand. The shape of the curves indicate that none of the three soils contain a large amount of clay.

By studying the curves the tension of ⅓ atmosphere seemed to bring all three soils in a close neighborhood of the field capacity. The soil used to obtain curve 1C seemed to reach the permanent wilting range at a tension of 12 atmospheres.

The pressure-membrane apparatus used to obtain the soil moisture characteristic curve is a very useful device for the irrigator and for the irrigation engineer. With some improvements the pressure-membrane apparatus and the associated soil moisture characteristic curve could be more useful to irrigation engineers in planning irrigation districts and for helping irrigators to plan efficient water application.

These improvements might be a change in procedure that could hasten the soil moisture toward reaching equilibrium with the membrane, and finding some absolute method of finding the per cent of moisture at field capacity and at the permanent wilting range. Perhaps a mathematical approach could be the solution to the problem.

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Soil Conditioners in Soil Conservation

(Continued from page 100)

that while bentonite performs a useful service in this respect, it cannot be depended on to retain water in ponds having an appreciable head, and that bentonite sealed bottoms have "blown out" under these conditions.

Dispersion of the soil with common electrolytes, such as the sodium salts, presents somewhat the same faults and merits as bentonite. However, electrolytes in quantities to flocculate the clay offer possibilities in conditioning soils for pond linings. In any event, there is always the possibility—as was the case with soil aggregants—of finding new materials that are more effective, both in sealing and bonding.

Modern chemicals that change the surface tension of water affect certain soil-water relationships and offer corresponding possibilities as soil conditioners. They increase the rate of capillary wetting when water enters dry soil and retard somewhat losses by evaporation by weakening the capillary tension that draws moisture upward to drying soil surfaces. They may have other effects. It remains to be seen whether these effects are of importance to soil and water conservation, but no resume of soil conditioners would be complete without some mention of possibilities in this field.

To sum up, we have not one but several kinds of soil conditioners. There are old ones and new ones. The value of the new ones like Krilium, Flotal and Terolas cannot be estimated fully until we know more of their advantages and limitations, and until prices have stabilized at competitive levels. As our information increases, we shall judge the changing status of the new arrivals by comparing their performance to the results that can be obtained by conservation applications of proved agronomic and engineering practices.

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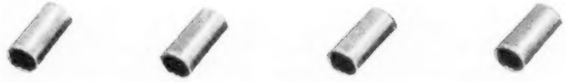

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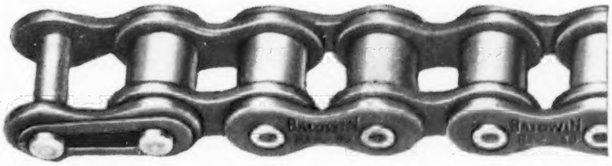

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A Pressure-Distribution Panel for Soil Moisture Investigations

By W. McNab Miller
MEMBER ASAE

USE of pressure-membrane apparatus for work on soil-moisture determinations, unsaturated permeability, and tension-resistance relationships of soil-moisture meters frequently give rise to conflict in demand for simultaneous use of different pressures for varying durations. Some are brief tests at a single pressure, while others demand extended and uninterrupted runs through progressively increasing pressures. Solution of this problem is most economically found through use of multiple-pressure regulators operating from a single high-pressure source, rather than through employment of several compressors. Provision for a full range of accurate downstream pressure control from a few pounds per square inch up to 15 atmospheres pressure entails use of several different regulators, with the attendant annoyance and difficulty of changing connections without loss of pressure in the apparatus, and prevention of leaks created by repeatedly making and breaking thread fittings.

The pressure-distribution panel (Fig. 1) described in this paper was designed to alleviate the above-mentioned problems. It is essentially a mounting board and switching device whereby a group of pressure-membrane apparatus (or other equipment requiring maintenance of supply of air at constant pressure) may be independently connected or disconnected from any one of four pressure regulators, regardless of its simultaneous use by other apparatus and without disconnecting any fittings.

All fittings shown in Fig. 1 are the standard type used in making up pressure systems. It is assumed that the reader is familiar with the design and operation of the pressure-membrane apparatus and will recognize the U-tube devices centrally mounted on the panel as mercury differential-pressure regulators. These regulators are designed to maintain, on the upper side of a rubber diaphragm, a pressure several pounds in excess of whatever pressure is maintained beneath the diaphragm in the soil chamber of the pressure-membrane apparatus. Therefore, there is a single air line leading to these mercury regulators, and two air lines leading from them to the pressure-membrane apparatus. These two lines from the mercury regulator pass through the panel, down the rear face, and back through the panel to a pair of ¼-in pipe manifolds under the mercury regulators near the lower edge of the face of the board. Each manifold consists of two pipe T's separated by a short length of pipe, and permits connecting three pressure-membrane apparatus to each mercury regulator. Additional T's could, of course, be installed to add more pressure-membrane apparatus to each mercury regulator (subject to table-space limitations), or the manifolds could be eliminated entirely and a single apparatus connected directly to the outlets of the mercury regulator. A pressure gage is furnished for each mercury regulator and is connected on the rear of the panel into the air line, leading from the mercury regulator to the upper manifold, which connects with the soil chamber, and the gage thus indicates the pressure supplied to the mercury regulator when the by-pass valve bridging the U tube is open. When the by-pass valve is closed, the gage reads not the supply pressure but the pressure in the soil chamber. In the interest of economy, two of the gages may be inexpensive types of only approximate accuracy, and the third a highly accurate test gage. This test gage can be used to calibrate the other two gages at frequent intervals by momentarily switching the mercury regulator bearing the test gage onto the same line as the other gages. It is to be noted that the by-pass valves of the regulators must be open at time of calibration.

For the pressure source we are using a small, high-speed, aircraft compressor with a maximum rating of 1000 psi (unknown discharge capacity), maintaining a pressure in a storage tank of 270-300 psi by means of a mercury pressure switch. From this source, a constant pressure of 250 psi is delivered to the panel through a pressure regulator mounted on the storage tank. While this regulator is not strictly necessary, it furnishes a buffer against pressure changes on the upstream side of the pressure regulators mounted on the panel board proper, thus furnishing a very constant supply at the outlet manifolds.

The main supply line runs across the top of the panel, connecting through drop lines with cutoff valves to four pressure regulators. The cutoff valves permit removing any regulator for replacement of valve seats, or other servicing, without taking the entire board out of operation. The first two pressure regulators have downstream ranges of 100-250 psi. The second two (pressure) regulators have downstream pressure ranges of 20-150 psi, (Continued on page 106)

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The author—W. McNAB MILLER—is assistant agricultural engineer, College of Agriculture, University of Wyoming.

ACKNOWLEDGMENT: The author gratefully acknowledges the assistance of Dean Stiteler, buildings and grounds department, University of Wyoming, in making helpful design suggestions and for constructing the panel described in this paper.

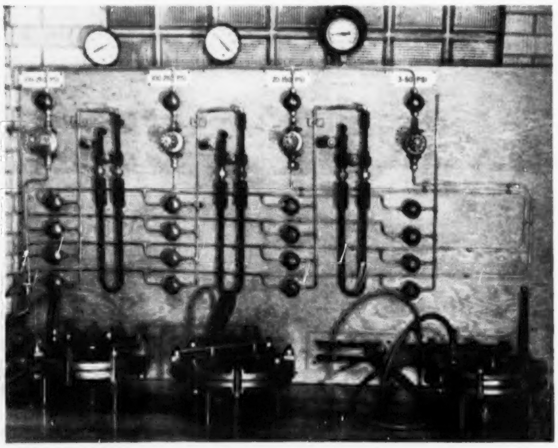
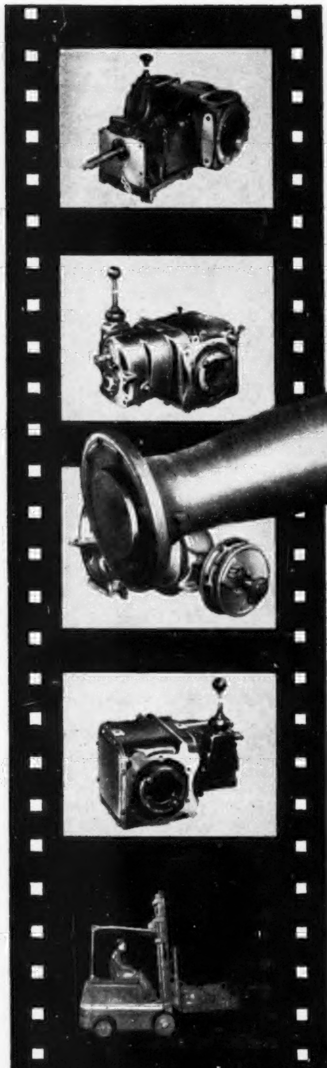
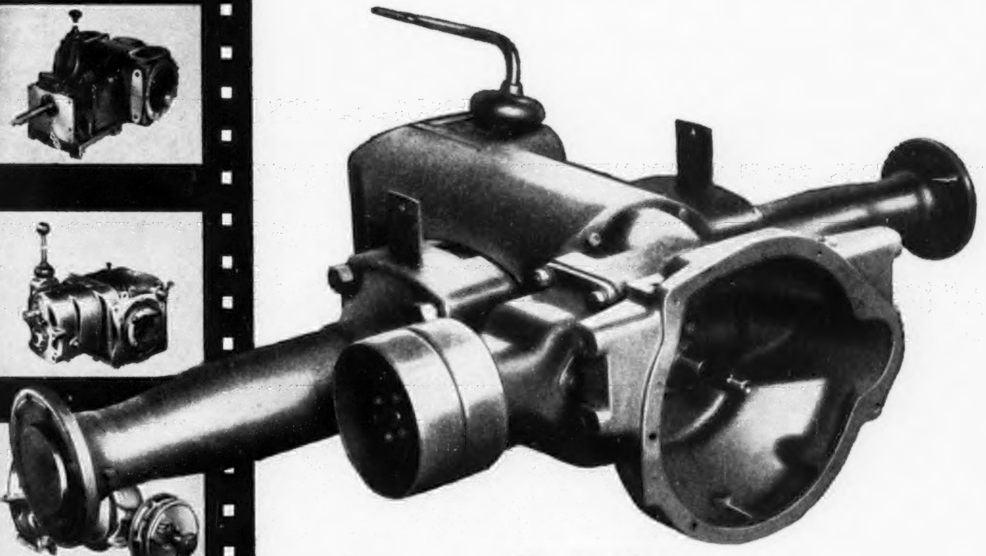


Fig. 1 A pressure-distribution panel for use in connection with soil-moisture investigations





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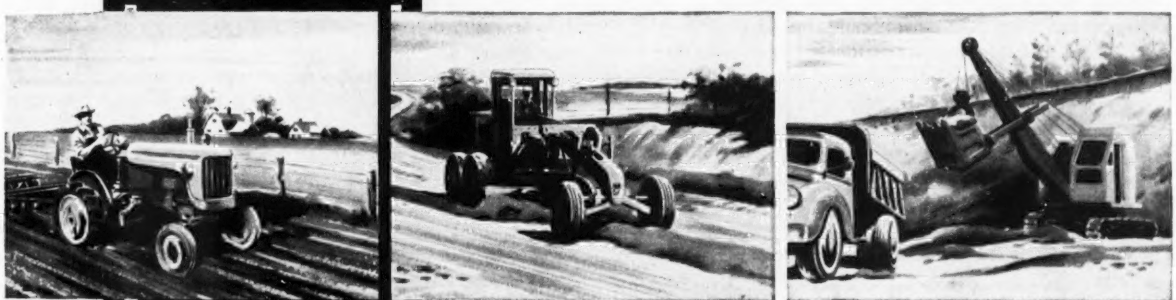

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Pressure-Distribution Panel

(Continued from page 104)

and 3-50 psi as illustrated. Duplication of the upper range permits use of one regulator entirely for 15 atmosphere determinations (one of our most frequent tests) while still leaving the board open for a full range of pressures from 3 to 250 psi.

Individual feeder lines run from each pressure regulator fully across the face of the board. The particular layout shown was chosen to permit a neater system by eliminating crossing of flush-mounted lines. Each of these feeder lines connects through an independent valve to each mercury regulator, giving a bank of four valves to each mercury regulator. A fourth bank of valves is shown on the board in anticipation of future installation of a fourth mercury regulator. Thus each horizontal row of valves connects the respective mercury regulator to a particular one of the four pressure regulators. It will be found helpful to paint the casing of each of the four (pressure) regulators a different color, and to paint the handles of each horizontal row of valves the color of the pressure regulator they connect with. It may also prevent momentary confusion to assign each mercury regulator a letter identification, and hang a tag bearing that letter to the pressure regulator from which the mercury regulator is operating at any particular time. While not immediately apparent from the illustration, all lines are flush-mounted to the board, except the manifold leading from the valves to the mercury regulators, and short nipples connecting the valves and pressure regulators.

In operation, three valves of any vertical bank are closed and one is open. Changing from one pressure range to another (changing pressure regulators) is accomplished by closing the open valve, and opening the appropriate one of the other three valves. In the process, the pressure in the soil chamber is never relieved. Whenever desired, two or more mercury regulators (with their attendant pressure-membrane apparatus) may be operated from the same pressure regulator. It will be realized that in this case the U-tubes of the mercury regulators must contain the same amount of mercury to give the same pressure in the soil chambers of the pressure-membrane apparatus.

When multiple-pressure-membrane apparatus are connected to a single mercury regulator, it will be desirable to install cutoff valves on each hose line unless all membrane apparatus are to have their pressure released or admitted at the same time. Such cutoff valves should be installed on the hose lines of all pressure-membrane apparatus operating off the mercury regulator bearing the test gage — even where only one unit is installed — so that gage calibrations can be accomplished without changing the pressure in that soil chamber.

A few additional construction details may be of assistance. A minor and self-evident rearrangement of the outlet fittings of the mercury regulator as received from the manufacturer is desirable to facilitate running the lines through the panel. The four pressure regulators are inletted into the face of the panel — the body of the regulators passing through the board — and are secured with U bolts. Valves and T fittings are solder type to eliminate sources of leaks, except flare fittings to pressure regulators to facilitate removal. The panel is secured to the table by means of shelf brackets so that ready access to the rear of the panel may be had by shifting the table away from the wall. This mounting is somewhat willowy, and where the panel and table will not receive some support from a wall, there should be additional bracing. The main line to the panel being rubber air hose permits shifting the table readily and at the same time insulates the panel from vibrations of the compressor. The small ¼-in plywood plaques, on which the outlet manifolds are mounted by U bolts, are used as shims so that the pipe elbows connecting to the manifolds with a short pipe nipple do not protrude from the rear face of the panel.

The line from the low-pressure regulator may be tapped to furnish a source of low pressure for use in conjunction with the pressure-cooker type of extraction chamber—either with or without a pressure-control bubble tower for the lowest tensions.

The cost for this panel (excluding labor and the mercury differential pressure regulators) was approximately $290. The following bill of materials was used in constructing the panel as illustrated:

Valves: 2 Foster pressure regulators, Y-15, ⅛" orifice, 300 psi upstream, 100-250 psi downstream; 1 Foster pressure regulator, Y-15, ⅛" orifice, 300 psi upstream, 20-150 psi downstream; 1 Foster pressure regulator, Y-15, ⅛" orifice, 300 psi upstream, 3-50 psi downstream; 4 Imperial valves No. 193CD, ¼" flare; 16 Imperial valves No. 193CDS, ¼" solder fitting, and 2 shut-off cocks, ¼" pipe x ¼" oxygen (One male union and shutoff cock can be salvaged from each mercury differential regulator as received from factory.)

Gages: 3 pressure gages, 0-300 psi, 5 lb graduations; 1 Marsh test gage, type 27, 4½", PCPSR, 0-300 psi, 1 lb graduations.

Brass flare fittings: 25 male connectors, ¼" pipe x ¼" tube; 37 flare nuts, ¼" tube; 7 male union, ¼" pipe x ¼" oxygen (or substitute shutoff cocks); 3 union T's, inverted flare, ¼" tube, and 4 male elbows, ¼" pipe x ¼" tube.

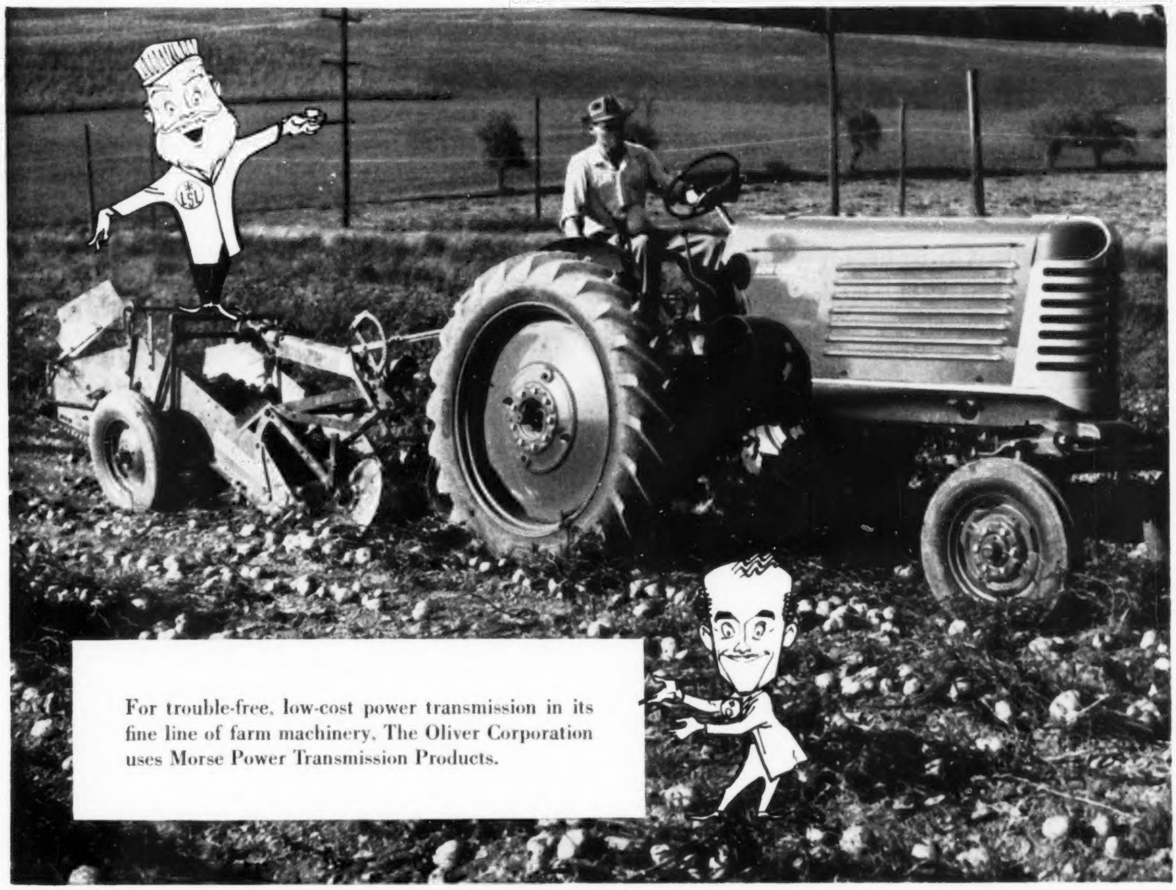
Pipe fittings: 8 brass bushings, ½" x ¼"; 4 brass couplings, ¼"; 8 nipples, ¼" x 2"; 4 nipples, ¼" x 10"; 8 nipples, ¼" x 1"; 8 nipples, ¼" x 6"; 8 nipples, close, ¼"; 20 T's, ¼"; 12 elbows, ¼"; 16 plugs, ¼", and 7 male unions, ¼" pipe x ¼" oxygen (or substitute shutoff cocks).

Miscellaneous: 16 U bolts, ¼" rod (to mount pipe manifolds); 24 brass solder T's, ¼" tube; 5 tube clamps, double; 21 tube clamps, single; 2 shelf brackets, 12" x 14"; 4 pcs 3-ply panel, 5" x 12"; 1 pc 5-ply panel, 42" x 72", and miscellaneous wood screws.

Recognition of Research

WE'RE beginning to see an increasing recognition of the need for more and better research in agriculture. The industry advisory committees, representatives of growers' associations, and other agricultural groups are giving more attention both to work now under way and to research that is needed. I am sure we all agree that farmers should not be left with a horse-and-buggy agriculture in their competition for efficiency with other industries in this jet-propelled age.

In planning ahead for research programs, we must consider not only the amount but also the kind of research we support. My point can best be illustrated by comparing research to the profile we use in soil classification. We can speak of the applied phase of research as the A horizon in the profile. It is the top soil. We have cultivated the plowed layer or A horizon intensively. Its potential for production has been reduced. It will not be adequate for future requirements. So we must dig more deeply. We must gain a far better understanding of the C horizon. In terms of basic research this is the material out of which we will formulate new concepts, find new clues that will lead to far greater productivity than we have known before. This is the goal of basic research in building our future foundation. By a prudent combination of basic and applied research we can keep our heads in clear air and our feet on fertile soil.— A. H. Moseman in *Chemurgic Digest* for December, 1952.



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INSTRUMENT NEWS

KARL NORRIS, Editor

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Moisture Content Determinations

By S. M. Henderson
MEMBER ASAE

THE commercial or "conversational" moisture content is based on the wet weight of the material, or per cent moisture (wet basis) = 100 × pounds of water ÷ by pounds of water + pounds of dry matter. The dry-basis moisture content is frequently used in scientific or engineering work. Per cent moisture (dry basis) = 100 × pounds of water ÷ by pounds of dry matter. Conversion from one base to the other is as follows, per cent moisture being M:

$$M_{wb} = M_{db}/(100 + M_{db})$$

and

$$M_{db} = M_{wb}/(100 - M_{wb})$$

The dry-basis moisture content is more convenient for many calculations since the change in moisture content is directly proportional to the change in pounds of water in the material under study.

Moisture contents reported in scientific or engineering documents should be designated as to base, e.g., $8_{db}\%$, 8%(DB), 8 (WB)%, or the base used should be noted in the text.

A moisture determination is no better than the sample upon which the determination is made. The sample must be taken in such a way that it represents the entire mass of material from which it comes.

Moisture-determining procedures (9)* are classed as primary or direct, and secondary or indirect. In the primary procedures, the moisture in a sample is removed and the quantity determined by weighing or measuring. The secondary procedures depend upon some characteristic of the material which is related to moisture content and must be calibrated against an official primary method.

"Official" methods are those which have been accepted by the Association of Official Agricultural Chemists (1) and are recognized by the U.S. Production of Marketing Administration (2). Moistures determined by "official" methods by certified inspectors are accepted by the courts.

PRIMARY METHODS

Oven (Official) (1, 2). Samples are first ground and then dried with direct heat in an air or vacuum oven. The loss in sample weight is considered to be moisture. Temperature and drying time vary from material to material. The specific procedure for each material must be followed.

Operating conditions for a few materials are listed below. Temperatures are Fahrenheit.

Grain and stock feeds—204 to 212 deg, 5 hr, vacuum oven, or 271 to 279 deg, 2 hr, air oven.

Dried fruits—158 deg, 6 hr, vacuum oven. (Also tentative for dried vegetables.)

Hops—140 deg, 3 hr, vacuum oven, or 218 deg, 1 hr, air oven.

Nuts (tentative)—158 deg, vacuum oven, weight at 2-hr intervals until loss per interval does not vary more than 3 mg per 2 gm sample.

Dried milk powder—202 deg, 2 hr, vacuum oven.

Molasses—140 deg, 2 hr, vacuum oven.

Toluene distillation (Official) (1, 10). The ground sample is distilled in toluene, 232 deg, until all the water has been removed from the sample, about 1 hr. The moisture removed is condensed and measured. Xylene (unofficial) which boils at 280 deg is also used in this system. Both are a fire hazard.

Brown-Duvel Moisture Tester (Accepted as Official) (10). Whole grains are distilled in a mineral oil which has a higher boiling point than the distilling temperature. The moisture which is driven off is condensed and measured.

Oil—Distillation Method (3). The weighed sample is placed in a pan which contains enough vegetable oil, e.g., Mazola, to cover it. A screen and cover are placed and the sample is heated to 293 deg for hay and 374 deg for grains which takes about 20 min. The loss in weight is moisture. In spite of the simplicity of the method and the low cost of the equipment, results nearly as accurate as those by official methods appear possible.

Operating conditions for all primary methods, that is, temperature, time, and particle size of sample if reduced, must be maintained within specified tolerances if reproducible results are to be expected.

SECONDARY METHODS

Electrical Resistance Meters (4, 9). Devices which measure the electrical resistance of products are calibrated against oven determinations and are adequate for many tests. Since resistance varies with the distribution of moisture within the material, material density, perhaps acid index and other factors, and since the characteristics of the moisture machine itself change with time, exact results cannot be expected. Tests can be made in a minute or less. Hay samples which contain a few wet pieces may give a completely erroneous indication of moisture content. Materials removed from a drier for a moisture check have a moisture gradient through each element and may also yield unsatisfactory results. Some studies with wheat (4) indicate errors of ¼ per cent can be expected. The Tag-Heppenstall electrical resistance moisture meter is accepted as official.

Dielectric Meters (4, 10). The capacitance of an electrical condenser varies with the moisture content of a material placed between its plates. This feature is used in dielectric meters for moisture determination. Meters of this type are as fast as the resistance meters and nearly as accurate (4). The sample is not destroyed which in some cases may be desirable if additional determinations are to be made.

(Continued on page 110)

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The author — S. M. HENDERSON — is a member of the agricultural engineering staff of the University of California.

ACKNOWLEDGMENT: The author is indebted to W. V. Hukill, U.S. Department of Agriculture, and E. C. Meyer, Minneapolis-Honeywell Regulator Co., for important contributions to this treatise.

*Numbers in parentheses refer to the appended references wherein detailed information concerning the method under discussion can be secured.

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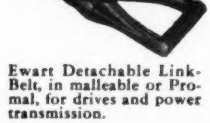

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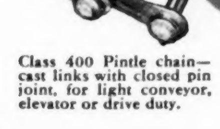

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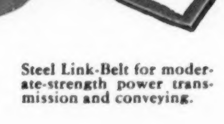

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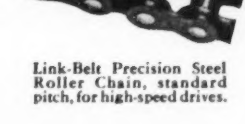

Link-Belt Precision Steel Roller Chain, standard pitch, for high-speed drives.

Moisture Content Determinations

(Continued from page 108)

Chemical Reaction Method. The sample is mixed with a chemical which sets up a reaction with the moisture in the sample. Some of the resultant compounds are gaseous and leave the system. The moisture content is related to the sample weight loss.

Titration Method. A ground sample of the material is mixed with certain chemicals and titrated with a special reagent. The method is simple and quick but to date has not been adapted to many agricultural materials (7).

Equilibrium Moisture Method (5, 8). The relative humidity of the air intermixed with stored grain (also other hygroscopic materials) reaches a value defined by the equilibrium moisture curve for the material under consideration (6). Thus the moisture content of the material can be determined by observing the relative humidity of the air within the mass. The electric hygrometer (5) now available commercially is specially suitable for this procedure. Although basically sound, this procedure is not recommended at this time for general use because of tolerance in the equilibrium moisture curve, possible performance variation of the relative humidity indicators, and the possibility that the sampled air is not in equilibrium with the grain. This method may not be expected to be usable for very high moistures such as in green hay because above 25 to 30 per cent moisture (wet basis) the relative humidity is very close to 100 per cent and large changes in moisture content are accompanied by very small changes in relative humidity.

FOR CONSIDERATION

1 The loss in weight of a sample when dried in an oven is due to loss of moisture and some loss of organic matter. Careful studies should be made to separate these losses.

2 A number of commercial moisture-determining devices have recently been placed on the market. Their performance should be studied impartially and the results made available.

3 Studies of the equilibrium moisture method should be made to establish over-all operating tolerances and to improve the method if possible.

4 An inexpensive simple, reliable moisture-determining procedure for farm use should be developed. (The existence of a number of procedures, many with admirable features, is recognized.)

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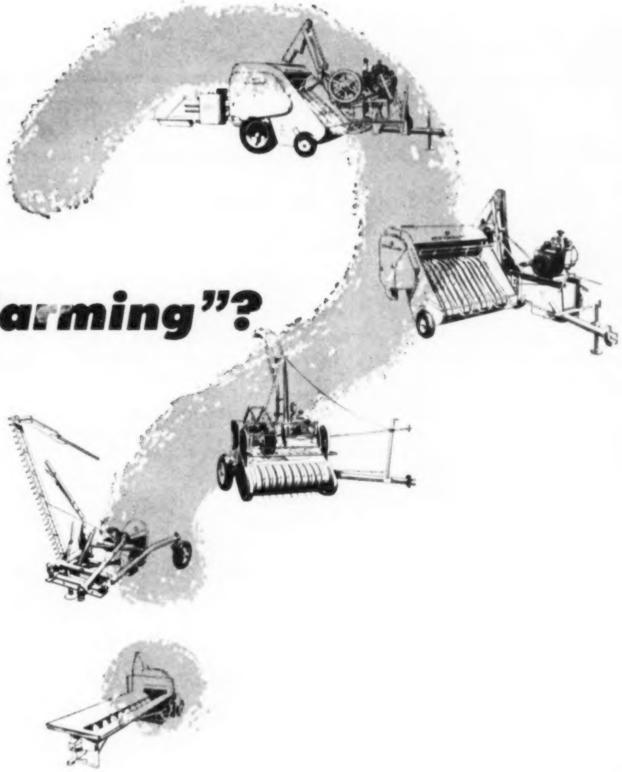
LIST OF RAPID MOISTURE-TESTING DEVICES FOR GRAIN AND RELATED COMMODITIES
(This is not intended as a complete list, and in presenting it, a guarantee of performance is not implied. Other devices may be available.)

Meter	Principle of operation	Manufacturer or distributor
All-Crop moisture tester	Direct heating	American Crop Drying Equipment Co., Crystal Lake, Ill.
All-Purpose moisture tester	Direct heating	Peirson-Moore Co., Lexington, Ky.
Aqua-Test moisture tester	Chemical reaction	Aqua-Test Co., Medford 55, Mass.
Brabender moisture tester	Direct heating	Brabender Corp., Rochelle Park, N. J.
Brown-Duvel moisture tester	Distillation	Seedburo Equipment Co., 223 W. Jackson Blvd., Chicago 6, Ill.
Chopin-rapid moisture meter	Direct heating plus chemical reaction	Thomas Robinson & Son, Ltd., Rochdale, England
Christie high-frequency desiccator U.S. 2,360,108	High-frequency dielectric heating	Phipps & Bird, Inc., 303 So. Sixth St., Richmond, Va.
Halross moisture meter	Dielectric	Halross Instruments Corp., Ltd., 387 Sutherland Ave., Winnipeg, Man., Canada
Hart moisture meter	Conductivity	Hart-Moisture-Meters, Grand Central Terminal, New York 17, N. Y.
Hygrotester	Dielectric	Paul Lippke, Mess-und Regel-Gerate, (22b) Neuwied am Rhein, Germany
Marconi moisture tester (type TF 933)	Conductivity	Canadian Marconi Co., 149 Portage Ave., East Winnipeg, Manitoba, Canada
National 15-min. moisture oven	Direct heating	National Mfg. Co., Lincoln, Nebr.
New Delmhorst moisture detector	Conductivity	Delmhorst Instrument Co., Boonton, N. J.
N.P.L. moisture meter	Dielectric	Baldwin Instrument Co., Ltd., Dartford, Kent, England
Radyne M2/A rapid moisture tester	High-frequency dielectric heating	Radio Heaters, Ltd., Wokingham, Berks, England
Speedy moisture tester	Chemical reaction	Thos. Ashworth & Co., Ltd., Vulcan Works, Burnley, England
Steinlite moisture tester	Impedance	Fred Stein Laboratories, 121 North Fourth St., Atchison, Kans.
Tag-Heppenstall moisture meter	Conductivity	Tagliabue Inst. Div., Weston Elect. Inst. Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Tag moisture meter	Dielectric	Tagliabue Inst. Div., Weston Elect. Inst. Corp., 614 Frelinghuysen Ave., Newark 5, N. J.
Thwing-Albert electronic per cent moisture meter	Conductivity	Thwing-Albert Inst. Co., Penn St. and Pulaski Ave., Philadelphia 44, Pa.
Toplis Simpson moisture (Meter A-63)	Dielectric	Lawrence & Newell, No. 1 Berry Square, Paignton, Devon, England
Universal moisture tester	Conductivity	Sheldrick Mfg. Co., Upper Sandusky, Ohio
Aqua Port	Conductivity	Hipkow-Zundapp-Werke, Dieselstrasse 10, Nurnberg, Germany
Carter-Simson moisture tester	Direct heat	Seedburo Equipment Co., 618 W. Jackson Blvd., Chicago 6, Ill.
Cenco moisture balance	Direct heat	Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.
Grain moisture meter RM101 (Kostensmittari RM101)*		Havulinna Oy., Helsinki-Helsingfors, Vuorikatu. 16 A Bergg., Puh. Vaihde 61456

*High-frequency loss factor of certain materials varies quite accurately with moisture content; 1 to 2 min per measurement; no grinding or pressing; 0.5% H2O in 90% of different kinds of grain.

Why "First in Grassland Farming"?



Back in 1940, New Holland put on the market a machine which helped start a new trend in farming. This was the first one-man automatic baler to pick up hay from the windrow and package it in twine-tied bales.

This early baler gave farmers a chance to make the ideas of grassland farming really work. It offset the growing labor problem . . . made larger acreages of grass possible . . . helped the farmer put up hay rich in the proteins and vitamins agronomists knew were being lost.

Since then, grassland farming and hay baling have come up fast. And New Holland has kept ahead all the way. After the early machines came the Model "76" and then the famous "77" which is today the highest capacity, fastest selling baler on the market.

Nor has progress been confined to a single product. In the New Holland line, a powerful wire-tie baler, forage harvesters, forage blowers, tractor mowers, spreader-seeders—these and others meet the demands of modern mechanized grassland farming.

Slogans are easy to coin, often hard to back up. Facts from the past and present plus plans for the future give New Holland the right to say, "First in Grassland Farming."

The New Holland Machine Company, a subsidiary of The Sperry Corporation.

NEW HOLLAND

"First in Grassland Farming"

New Holland, Pa. • Minneapolis • Des Moines • Kansas City • Brantford, Ontario

NEWS SECTION

Michigan Section Winter Meeting

IVAN D. WOOD, president of ASAE, has been scheduled to address the Michigan Section of the Society at its winter meeting in Detroit, Saturday, February 14.

The meeting is to be held at the Detroit Edison Boat Club, with registration starting at 9:30 a.m. Wm. G. Buchinger is chairman in charge of the program.

A tour through Connor's Creek Power Plant will start at 10:00 a.m. and occupy the remainder of the morning. Those taking in this feature will be asked to show their ASAE membership cards or other satisfactory identification as to citizenship.

Returning to the Club for lunch, the Section will hear comments by J. R. Schram, Section chairman; a talk, entitled "Why Registration," by D. E. Trefry, past-president of the Professional Engineers of Detroit, and the address by President Wood.

Varied interests are represented in the afternoon program featuring the following talks: "Tourist Resources of Michigan," by C. A. Gunn, Michigan State College; "Heating Controls," by J. E. DePuy, Minneapolis-Honeywell Regulator Co.; "Farming in the Columbia Basin," by Chris Nyberg, The Oliver Corp.; and "Tractor Safety," by Robert G. White, Michigan State College.

Ohio Section to Meet at Coldwater

AN INVITATION to meet at the Coldwater, Ohio, plant, of the New Idea Division, Avco Mfg. Corp., has been accepted by the Ohio Section of ASAE. The Section will hold its winter meeting there Saturday, March 7.

A two-hour inspection trip through the plant is scheduled to start at 9:30.

Following a lunch at the Methodist Church the Section will assemble at the city hall to hear and discuss scheduled papers on farm mechanization.

T. P. Christen, chairman of the Section, will open the afternoon session with brief remarks. Featured subjects and speakers will be "Problems Involved in Developing a New Piece of Farm Machinery," by Bruce K. Tice, New Idea Division; "Small Grain Harvesting Studies," by William H. Johnson, Ohio State University; and "Are Our Farms Over-Mechanized?" by John Babcock, New Idea Division.

Missouri A-E Curriculum Accredited

ACCORDING to word received from Dean Huber O. Croft of the college of engineering, University of Missouri, the agricultural engineering curriculum of that institution was duly accredited during 1952 by the Engineers' Council for Professional Development (ECPD), but the listing of the approved curriculum was inadvertently omitted from the 1952 ECPD annual report.

This makes the second agricultural engineering curriculum to be accredited by ECPD during 1952, the other being the one at Rutgers University.

There are now a total of 17 ECPD accredited agricultural engineering curriculums in the land-grant colleges of the following states: California, Idaho, Illinois, Indiana (Purdue), Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Nebraska, New Jersey (Rutgers), Oklahoma, Oregon, Texas, Utah, and Virginia.

New Water Pumping Subcommittee

ACCORDING to announcement by G. E. Ryerson, chairman, ASAE Soil and Water Division, a new subcommittee with primary interest in water pumping and distribution is being organized as part of the activities of the Division's Committee on Rural Water Supplies headed by E. L. Arnold. G. E. Trisler will be chairman of the new subcommittee, the other members of which will be K. L. McFate, C. K. Kline, W. H. Sheldon and A. H. Schulz. As its first activity the subcommittee will initiate a survey of the general field of water pumping and distribution.

National Conference on Instrumentation

THE electrical engineering department of Michigan State College, in cooperation with the National Science Foundation, National Bureau of Standards, Instrument Society of America, and American Society for Engineering Education, announces an invitational national collegiate-industry-government conference on instrumentation to be held on its campus, March 19-20, 1953.

The conference is being called in recognition of the growing importance and potential of instrumentation in research and production and to the national defense. The objectives of the conference are (a) to relate the role and needs of instrumentation in production and research to college interests and responsibilities, (b) to review current instrumentation activities in the colleges, (c) to suggest specific activities the colleges might undertake in this field, and (d) to suggest specific ways by which industry might assist the colleges in these activities.

Educational and industrial administrators and others interested in the field of instrumentation, who would like additional information concerning the conference should write R. J. Jeffries, department of electrical engineering, Michigan State College, East Lansing, at once, as attendance will be limited.

ASAE Meetings Calendar

February 27 and 28—PACIFIC COAST SECTION, California Polytechnic College, San Luis Obispo, Calif.

March 7—OHIO SECTION, New Idea Farm Equipment Co., Coldwater, Ohio

April 9—OKLAHOMA SECTION, Oklahoma A. & M. College, Stillwater.

April 10 and 11—SOUTHWEST SECTION, Oklahoma A. & M. College, Stillwater, Okla.

April 23 and 24—PENNSYLVANIA SECTION, Agricultural Engineering Bldg., Pennsylvania State College, State College

May 1 and 2—VIRGINIA SECTION, Natural Bridge Hotel, Natural Bridge, Va.

June 15 to 17—46TH ANNUAL MEETING, Hotel William Penn., Pittsburgh, Pa.

December 7-9—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Michigan

Committee Changes Name

COMMITTEE on Farm Work Efficiency is the new name of the ASAE committee formerly called the "Committee on Farm Work Simplification." The new name is believed to be more expressive of committee objectives, though it is not entirely satisfactory for identifying the committee's activities.

The chairman of the Committee is Carl R. Olson, who operates his own farm management service at Freeport, Ill. Other members of the committee are I. D. Mayer, P. R. Hoff, H. L. Garver, J. H. Levin, W. D. Hemker and Thayer Cleaver.

Chairman Olson points out that in the light of present labor shortage on most farms and the many radical technological changes in the agricultural industry, the Committee has an exceptional opportunity to initiate and advance timely projects in the field of farm work efficiency. He will welcome suggestions from any ASAE members.

Aluminum and Plastics for Farm Machinery

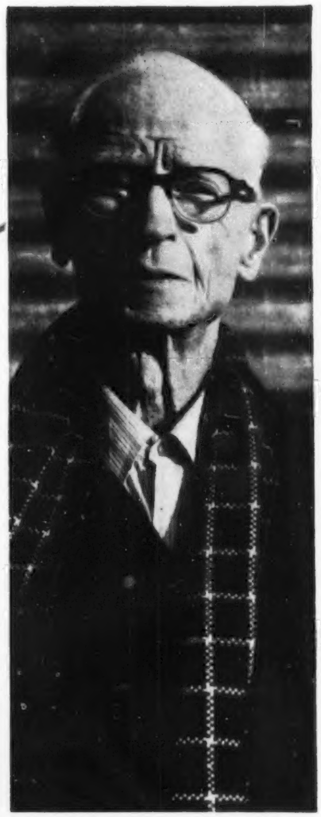
THE above title indicates the subjects presented at a dinner meeting of the Iowa-Illinois Section of the American Society of Agricultural Engineers held in the American Legion Club Room in East Moline on the evening of January 16.

There were 113 members and friends of the Section who attended the meeting. Following the dinner, the program was opened by I. R. Dawson, dvelopment engineer, Aluminum Company of America, who presented an interesting, illustrated lecture on the application of aluminum in agricultural machinery.

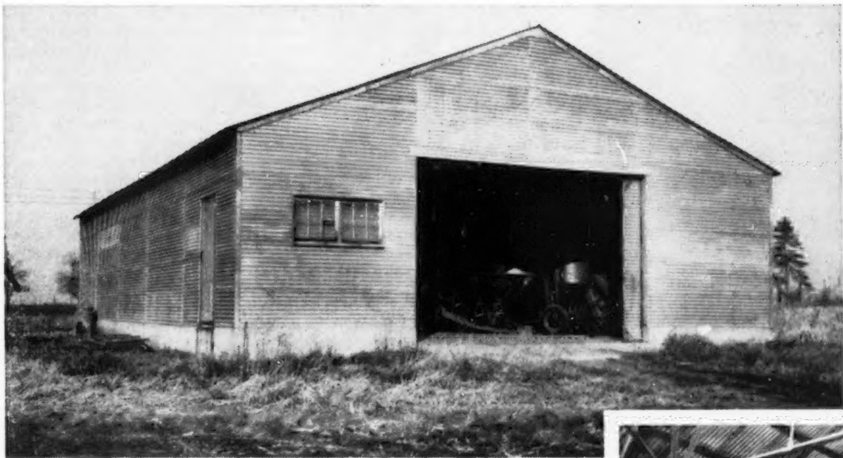
The second speaker was George Hammond, manager, appliance parts division, plastics division, Owens-Corning Fiberglas Corp., who discussed the subject of fiberglas reinforced plastics, a new structural material, with particular reference to its possible applications in farm machines.

Both talks were of outstanding interest especially to engineers of the farm equipment industry. The next meeting of the Section is scheduled for March 6. One of the subjects to be on this program will be production practices as related to design engineering, to be presented by the executive vice-president of one of the major farm equipment manufacturers.

"My steel building is a lot safer from fire"



says John R. Cosgrove, Utica, Illinois



Mr. Cosgrove, owner of a 240-acre farm, wanted the right machinery storage building for his tenants' modern machinery. He selected this 36′ x 60′ drive-through steel building. "It's a fine shed," says Mr. Cosgrove. "We carry only $500 fire insurance because we feel there is very little risk."

Mr. Fruin, the farm manager, has this to say, "In selecting a steel building, we based our decision on economy in erection, low maintenance, and adaptability for many uses because of the complete open interior area.

"In winter we have built portable hog houses inside the shed, thus keeping lumber dry and workmen protected from wind and rain. Machinery is easy to store, by driving through and rolling to one side. And the doors handle easily."

If you want all-around safety in your farm buildings, check up on *steel* buildings. Fire underwriters consider steel construction to be the safest of all. And steel is stronger. Steel buildings have gone through winds of 100 miles per hour without a trace of damage. Just take a little time to investigate, and you'll see why so many farmers agree that *you get more for your money when you build with steel.*

SEND THIS COUPON FOR FURTHER INFORMATION

Agricultural Extension Section, United States Steel Corporation
Room 2810M, 525 William Penn Place, Pittsburgh 30, Pa.

I am interested in steel buildings for the following:

- ☐ grain storage
- ☐ hay storage
- ☐ machinery storage
- ☐ other ....
- ☐ cattle shelters
- ☐ dairy barns
- ☐ poultry shelters

Approximate size or capacity ....

Send information to:

Name ....

Address .... **Town** ....

County .... **State** ....

United States Steel Corporation is a steel producer, not a steel building fabricator. Your request, therefore, will be sent to building manufacturers who fabricate steel buildings for farm use.

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G.L.F. depends on STOW flexible shafting for speedy grain delivery!

"Since installing STOW flexible shafting on our bulk feed delivery units, we have lost no time due to breakdowns and have had no maintenance problems in over five months of continuous service", says Mr. Joseph Collins, manager, Broome G.L.F. Elevator.

This STOW flexible shaft application replaces a universal joint series which would not stand up under the rugged conditions to which it was subject during deliveries to farms. Primary cause of the failure, according to Mr. Collins, was the steep angles through which the universal joints had to operate. Prior to the installation of STOW flexible shafting, Broome G.L.F.'s grain delivery units suffered frequent breakdowns, each of which involved three or four-hour delays and upped delivery costs.

This is another excellent example proving the efficiency, the practicability of STOW flexible shafting. Why not consult with STOW engineers on *your* next power transmission problem?

WRITE TODAY for your FREE Torque Calculator and Bulletin 525 containing complete data on STOW flexible shafting. No obligation, of course.

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first in flexible shafting since 1885

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NEWS OF ASAE MEMBERS

L. A. Hawkins recently retired as general supervisor of the farm practices section, consumer relations department, International Harvester Co., after completing 30 years of service with the Company. Mr. Hawkins joined the Company's agricultural extension department in 1922, to which he brought a valuable combination of technical training and field experience in working with farm people. Through the intervening years of service in various departments, he subsequently joined the consumer relations department in January, 1935, and for the past few years has served as general supervisor of farm practice research. In his service for the Company he has gained wide repute as an authority on agricultural, horticultural, and soil conservation practices. His future activity will be devoted to a farm which he recently acquired near Houston, Mo.

• • •

Herbert J. Hurme recently completed an enlistment in the U.S. Army and has been accepted for graduate study in agricultural engineering at the University of Maine.

• • •

Russell R. Poynor was recently appointed general supervisor, farm practice research section, consumer relations department, International Harvester Co. He succeeds L. A. Hawkins who has retired.

Mr. Poynor holds a civil engineering degree from the University of Wisconsin and an agricultural engineering degree from Purdue University. Following graduation from Wisconsin, he spent one year in the employ of the U.S. Soil Conservation Service. He also served three years on the agricultural engineering staff of Utah State Agricultural College and five years on the agricultural engineering faculty at Purdue. In 1945 he joined the Canton works of the Harvester Company as engineering specialist, and three years later was transferred to the general office in Chicago as agricultural engineer in the farm implement division. He was transferred again in September, 1949, to the Company's consumer relations department, as soil conservation engineer.

Mr. Poynor became a member of ASAE in 1937, and during the years 1950-52 served as both vice-chairman and chairman of the Society's Soil and Water Division. He is presently chairman of the Steering Committee of the Division.

• • •

F. Earl Price, dean, school of agriculture—also director of both the agricultural experiment station and the agricultural extension service—at Oregon State College, was honored at the recent annual convention of the Association of Sprinkler Irrigation Equipment Manufacturers, with a special honor award for his services as a pioneer in the development of sprinkler irrigation. Dean Price is credited with leadership in organizing regional groups for research studies of irrigation water use leading to the systematizing of irrigation practices, originating formulas for water application, testing and improving equipment design, and bringing the benefits of sprinkler irrigation to agriculture. Dean Price is a former head of the agricultural engineering department at Oregon State College, and has played a prominent part in the development of agricultural engineering activities in the Pacific Northwest.

• • •

Oscar W. Sjogren having completed 24 years of service with the John Deere Killefer Company, Los Angeles, retired on December 31st last. He joined the Killefer organization in 1929 as supervisor of agricultural sales in charge of field experimental work and development projects. Since that time he has served as head of the experimental department, sales manager, and special representative. He has devoted a greater part of his life to the scientific use of farm machinery, and prior to joining the Killefer organization he was head of the agricultural engineering department at the University of Nebraska.

Mr. Sjogren is a past-president of the Society, having served in that capacity during the Society year 1926-27. He became a member of the Society in 1916, and was elected a Life Fellow of ASAE in 1950.

• • •

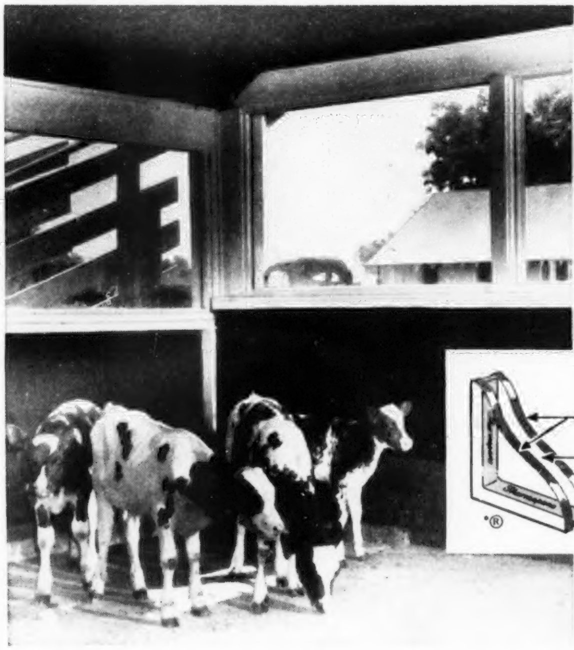
John W. Wilkins is now associated with the Eagle Belting Co., Chicago. He was formerly in the marketing service department of Armco Steel Corp., Middletown, Ohio.

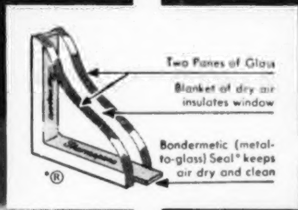
• • •

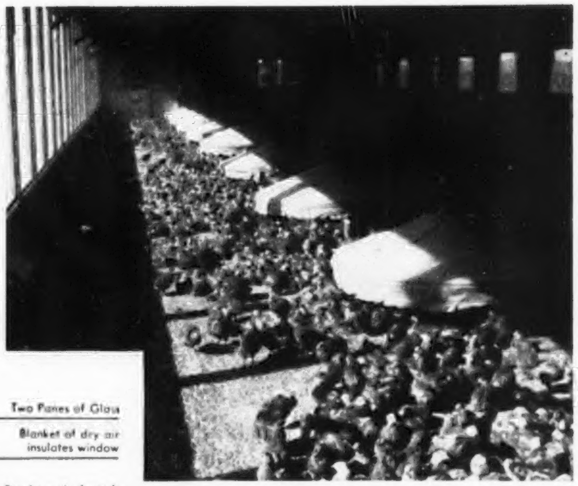
Milton D. Shanklin recently completed work on his master's degree in agricultural engineering at the University of Missouri and is to be associated with the Portland Cement Association at Columbus, Ohio.

• • •

Hugh A. Templeton, Brantford, Ont., has accepted an assignment with FAO to work with the government of Ceylon on farm machinery, a project directed by E. A. Hardy. Mr. Templeton, who was born near London, England, came to Canada in 1931 and obtained a diploma in agriculture at Macdonald College in 1933. During World War II he served with the Royal Canadian Artillery for over five years. He graduated from the University of Saskatchewan in 1950 and has worked for the Cockshutt Farm Equipment Co. of Brantford and the John Deere Plow Co. of Hamilton, Ont., since that time.







Here's PREVENTIVE MEDICINE that animals go for

Ever notice how animals huddle in a spot of sunshine on cold days? They like its warmth. And perhaps they know it's good for them.

In the October 1952 issue of *Agricultural Engineering*, it was stated by A. H. Groth and Merle L. Esmay: "The newborn of all species of domestic animals are quite susceptible to sudden changes in wet and dry-bulb temperatures and to cold drafts. . . Calves should be in a part of the barn that can be reached by direct sunlight and protected from drafts."

This points out practical values of bringing in sunlight and using insulated windows to *keep* more heat inside and to reduce drafts. Warmer buildings are drier buildings because more moisture is carried off by warmer air. The combination of greater warmth and dryness creates conditions favorable to greater production of meat, milk and eggs.

CUTS MAINTENANCE, TOO. With winter dampness reduced, there's less condensation—less rot or rust. That saves time and money.

How is this all achieved?

1. Big windows facing south bring in winter sun.
2. An overhang shades out the high summer sun.
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You can now get Farm *Thermopane* insulating glass for lower cost double glazing of service buildings. *Thermopane* is sold by glass and building supply distributors and dealers. Mail the coupon for full information.

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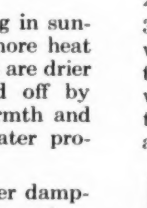

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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

ADAMS, CHARLES E.—Project engineer, Allis-Chalmers Mfg. Co., La Porte, Ind. (Mail) 208 H St.

ADCOCK, HENRY C.—Parts representative, International Harvester Co. (Mail) 505 W. Hancock St., Lakeland, Fla.

ANDERSON, CELIUS R.—Marine engineer, Bureau of Ships, U.S. Navy Dept. (Mail) Starbuck, Minn.

BARNUM, C. S., JR.—Vice-president of sales, American Portable Irrigation Co., Hackettstown, N. J.

BINKLEY, JOHN B.—Owner, Binkley Pump Service, Santa Rosa, Calif. (Mail) 855 Baird Rd.

BRANNAKA, HAROLD E.—Extension agricultural engineer, Pennsylvania State College, State College, Pa. (Mail) 729 Windcrest

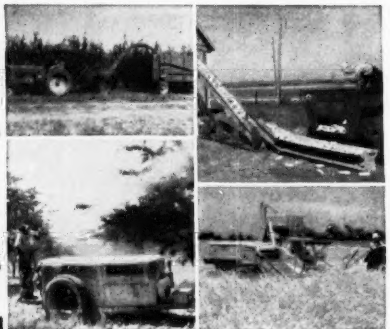
CALVERT, J. H.—Industrial relations manager, Harry Ferguson, Inc., Roosevelt Park Annex Station, Detroit 32, Mich.

CAMPBELL, J. JAMES — Agricultural engineer, S. L. Allen Co., Philadelphia, Pa. (Mail) 90 E. Logan St.

CARPENTER, HAROLD E.—Student, University of Tennessee (Mail) 349 Jefferson Ave., Oak Ridge, Tenn.

CAVIN, KAY T. — Agricultural engineer (SCS), USDA. (Mail) Sturkie, Ark.

COCHRAN, DEMPSEY W.—U.S. Army. (Mail) 501 Signal Service Co., Ft. Monmouth, N. J.



Most Specified...
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HEAVY-DUTY
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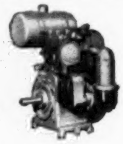
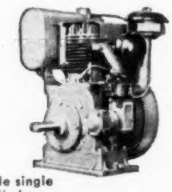
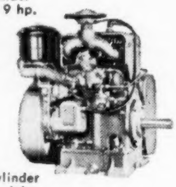
ENGINES

Power to Fit the Machine


Single cyl. 3 to 8½ hp.


4-cycle single cylinder 6 to 9 hp.


2-cylinder models 7 to 14½ hp.


V-type 4-cylinder 15 to 36 hp.

- Specified as integral power units by more than 500 original equipment manufacturers . . .
- Delivering dependable, efficient power on a greater variety of service applications than all other makes of engines combined, in a 3 to 36 hp. range...
- Supplying Most H. P. Hours of heavy-duty on-the-job power in all weather, all climates . . . Tapered roller bearings at both ends of the crankshaft, preventing bearing failure, are typical heavy-duty features . . .
- Constantly demonstrating the outstanding efficiency and trouble-free dependability of AIR-COOLING . . . No climate too hot, no climate too cold.

These are some of the factors worth considering in the selection of engine power for farm equipment. Detailed engineering data and descriptive literature on request.

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CORBETT, WYLIE E.—U.S. Air Force. (Mail) Box 35, Kirkland AFB, N. M.

DAVIDSON, WILBUR G.—Development engineer, B. F. Goodrich Co., 500 S. Main St., Akron, Ohio

DOVEY, KENNETH A. W.—Sales manager, Equipment, Ltd., Ferguson Division, P.O. Box 1110, Nairobi, Kenya, Africa

DRYER, FORREST E.—U.S. Air Force. (Mail) Randolph, Ill.

DYLLA, ANTHONY S. — Agricultural engineer (SCS), USDA. (Mail) Hurley, S.D.

EHLERS, ARNOLD M.—District sales manager, Martin Steel Products Corp. (Mail) 2345 N. 64th, Lincoln, Nebr.

FERGUSON, JAMES D.—Assistant manager, tire division, Dominion Rubber Co., Kitchener, Ont., Canada

FREEBURG, ROBERT S.—U.S. Navy. (Mail) Seneca, N. M.

FURMAN, GENE F.—Farmer, 122 9th Ave., NW, Minot, N. D.

GALLWITZ, KARL H. T.—Professor, director des Landmaschinen-Institutes der Universitat Gottingen, Kreuzbergring 34, Gottingen, Germany

GARMAN, JAMES A.—2nd Lt., safety engineer, U.S. Air Force, 81st Air Base Sq., Greater Pittsburgh Airport, Coraopolis, Pa.

GATES, LAUREN W.—Trainee, New Holland Machine Div., The Sperry Corp., New Holland, Pa. (Mail) 424 W. Main

GUARD, BAILEY D. — Publisher, Breeder's Gazette Publishing Co., Louisville 6, Ky.

HAAKENSTAD, SYDNEY H.—Souris, N. D.

HARRISON, MARVIN G.—Agricultural engineer, Southside Electric Cooperative, Crewe, Va. (Mail) 602 Virginia Ave., W.

HOWARD, WILLIAM J.—Trainee, New Holland Machine Div., The Sperry Corp., New Holland, Pa. (Mail) 100 W. Main

HOWELL, ALBERT M. III—Assistant director of agriculture, Government of American Samoa, Pago Pago, American Samoa

JOHNSON, EDWARD M.—U.S. Army. (Mail) Box 14, State College, Miss.

JONES, MALLIE B.—Engineering assistant, Virginia Electric & Power Co., Norfolk, Va. (Mail) 2427 Darden St.

KAHLER, MAHLEN F.—Jr. engineer, engineering research division, John Deere Waterloo Tractor Works, Waterloo, Iowa

KELLOGG, CHARLES W.—Trainee, New Idea Div., Avco Mfg. Corp. (Mail) 313 E. Fulton St., Celina, Ohio

KENNADY, A. B., JR.—Sales manager, irrigation division, Woodin & Little, 33 Fremont St., San Francisco 6, Calif.

KNIGHT, LOYD A.—Engineer, A. Duda & Sons. (Mail) 1104 Elm Ave., Sanford, Fla.

LAWLER, THERON O.—Market development, Bituminous Coal Research, Inc., 488 W. Sixth Ave., Columbus 1, Ohio

LONGSTAFF, CHARLES W.—British Columbia Sugar Refining Co. (Mail) 441 Victoria St., Ladner, B.C., Canada

MARMORINE, MARVIN O.—Foreman, Green Giant Co., Glencoe, Minn. (Mail) Box 32

MARTIN, CECIL N. — Soil conservationist (SCS), USDA. (Mail) Box 935, Clarkesville, Ga.

MATHEWS, THOMAS C.—Owner, Diamond "M" Ranch, Box 641, Williston, Fla.

MERSON, JAMES F.—Head, agricultural engineering dept., California State Polytechnic College, San Luis Obispo, Calif.

MONKMEYER, PETER L.—U.S. Army. (Mail) 1795 Riverside Dr., New York 34, N. Y.

MORROW, ROBERT C.—Trainee, The Massey-Harris Co. (Mail) 1201 Iowa Ave., Ames, Iowa

MURLEY, THOMAS L.—Supervisor of service, J. I. Case Co. (Mail) 2320 Tremont Rd., Columbus 12, Ohio

NELSON, LEROY C.—Farm manager, R R 1, Mount Valley, Kans.

NETLAND, THEODORE—Plant manager, Ed. Spiekerman Concrete Pipe Co., Lodi, Calif. (Mail) 430 S. Church St.

(Continued on page 118)

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IN A TYPICAL FARM PLAN

These Power-Packed Graders have the speed and capacity to get the job done ON Time and IN Time

With exclusive All-Wheel Drive for maximum tractive effort; exclusive All-Wheel Steer for unequalled maneuverability, and with its heavy-duty bulldozer, the Austin-Western Power Grader is a top performer on a wide variety of soil and water conservation practices. Equally important is its ability to move earth *fast* . . . excellent insurance that all portions of a farm plan that should *function* together will be *finished* together—*on* time and *in* time. The whole story is yours for the asking—and well worth reading.

Building terraces

Shaping waterways

Cutting outlet ditches

V-type drainage ditches

Shallow drainage ditches

Tile ditches

Filling gullies

Clearing brush

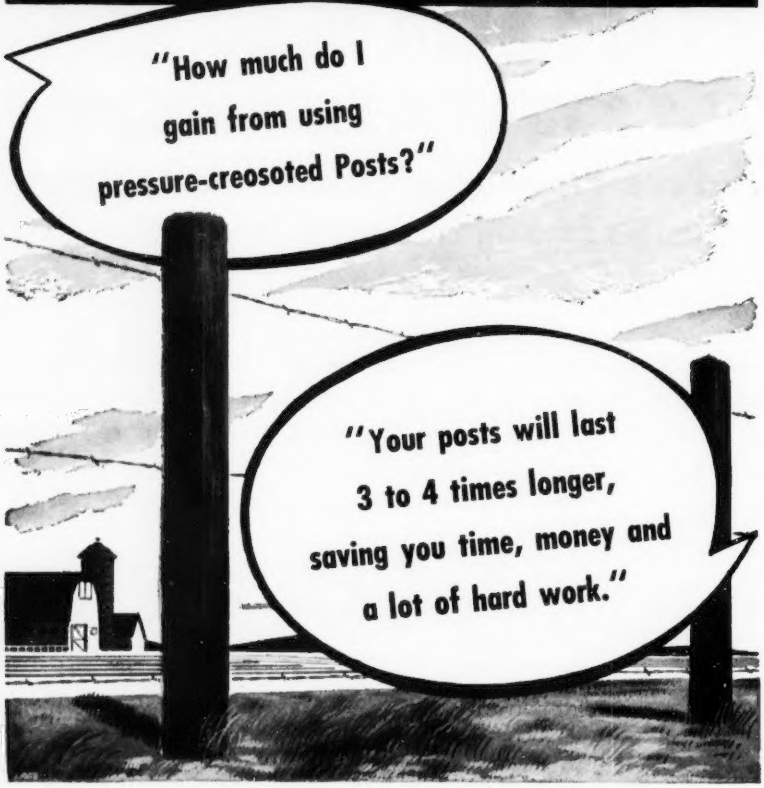
Spreading spoil banks

Austin-Western
Power Graders
Road Rollers · Motor Sweepers

BALDWIN BLH LIMA-HAMILTON
Construction Equipment Division

Manufactured by
AUSTIN-WESTERN COMPANY
Subsidiary of Baldwin-Lima-Hamilton Corporation
AURORA, ILLINOIS, U.S.A.

A FARMER ASKS . . .



FARMERS report that wood posts stay sound and usable for 30 and even 40 years when they are pressure-treated with creosote. Pressure-creosoting *completely* protects the wood from insects and fungi that cause decay. It makes the wood more resistant to burning . . . reduces the likelihood of a grass fire destroying a fence.

You're doing right by the farmers in your district if you always recommend pressure-creosoted fence posts. Remember . . . creosote is the *only* preservative that keeps wood sound and serviceable under severe conditions for more than 30 years!

KOPPERS COMPANY, INC., PITTSBURGH 19, PA.

Tar Products Division

DISTRICT OFFICES: Woodward, Ala. · Chicago, Ill., 122 S. Michigan Ave.
New York, N. Y., 350 Fifth Ave. · Boston, Mass., 250 Stuart Street
Los Angeles, Calif., 727 E. Gage Ave. · Pittsburgh, Pa., Koppers Building

KOPPERS

All Standard Specifications/

Creosote

The Performance-Proved Wood Preservative

Applicants for Membership

(Continued from page 116)

REED, WILLIAM B.—Serviceman, International Harvester Co., Regina, Sask., Canada. (Mail) 1614 Garnet St.

RIDDLE, CHARLES F.—Design engineering, Lavers Engineering Co., 608 S. Dearborn St., Chicago, Ill.

RIEKENBERG, RALPH M. — Product design engineer, Comfort Equipment Co. (Mail) 8317 W. 61st St., Merriam, Kans.

RILEY, JOHN P.—Assistant hydraulic engineer, Water Rights Branch, Department of Lands & Forests, B. C. Provincial Government, Victoria, B.C., Canada. (Mail) 1322 Broad St.

ROBB, JOHN K. — Agricultural engineer (SCS), USDA. (Mail) 1112 Oregon, Hiawatha, Kans.

ROSENBERGER, PAUL C.—U.S. Army. (Mail) Estherville, Iowa

ROY, BILLY B. — Agricultural engineer, Bureau of Indian Affairs, USDI. (Mail) Western Shoshone Indian Reservation, Owyhee, Nev.

SAENZ, ALBERTO (MAROTO)—Professor of soil conservation, University of Costa Rica, San Jose, C. A. (Mail) Av. 10, Cs. 13-15

SALISBURY, GRANT—Field editor, Capper's Farmer, 912 Kansas Ave., Topeka, Kans.

SAM, PIERRE D.—Agronomist, SCIPA, Damien, Port au Prince, Haiti, W. I.

SCHLETER, FRED—Power use director, Jackson County Rural Electric Membership Corp., Brownstown, Ind.

SCHUMACHER, WALTER B.—Trainee, New Holland Machine Div., The Sperry Corp., New Holland, Pa. (Mail) Hillcrest Rd.

SNOW, MILTON M.—Coordinator of photographic work, International Harvester Co. (Mail) R R 1, Downers Grove, Ill.

SPIES, HENRY R. — Student, University of Illinois. (Mail) Ashkum, Ill.

STEVENS, EDWIN L.—Sr. engineer, Wood Bros., Inc. (Mail) 4121 Cornell, Des Moines 13, Iowa

SUTTON, D. LEE—Owner, The Pump Shop, 355 E. John St., Salinas, Calif.

VOGELSANG, FRANCIS H.—Designer, Allis-Chalmers Mfg. Co., LaPorte, Ind.

WANN, CAVE M. — Agricultural engineer (SCS), USDA. (Mail) Paluxy, Tex.

WILLIAMS, M. S., JR.—U.S. Army. (Mail) R R 1, Moore, S. C.

WITT, LEE H., JR. — 2nd Lt., Ordnance Corps., U.S. Army, 9361st TSU, Red River Arsenal, Texarkana, Tex.

WOBBE, WILLIAM W. — District manager, Western Aluminum Corp., Portland, Ore. (Mail) 4036 SE Francis

TRANSFER OF MEMBERSHIP GRADE

ANDERSON, WILLIAM A. — Sales engineer, Florida division, Food Machinery and Chemical Corp., Lakeland, Fla. (Mail) 409 W. Poinsettia (Affiliate to Member)

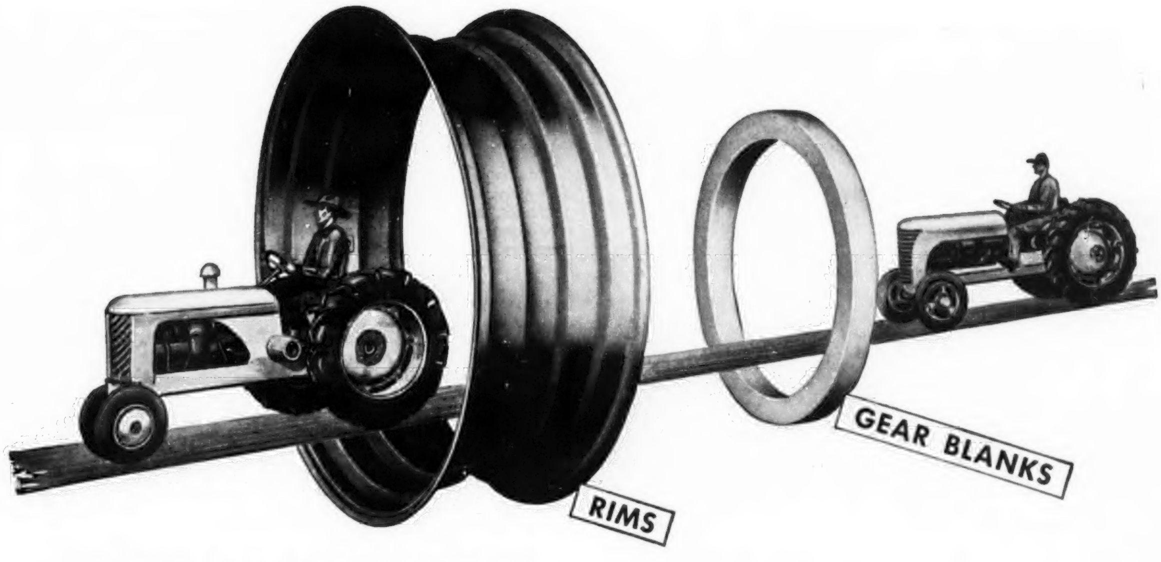
HUDSPETH, ELMER B., JR.—Agricultural engineer, Texas Agricultural Experiment Station, R R 1, Lubbock, Tex. (Associate Member to Member)

OLVER, ELWOOD F.—Associate professor of agricultural engineering, Pennsylvania State College, State College, Pa. (Associate Member to Member)

RICE, DUDLEY W.—Sales manager, National Electric Products Corp., Chamber of Commerce Bldg., Pittsburgh, Pa. (Affiliate to Member)

WALTON, HAROLD V.—Associate professor of agricultural engineering, Pennsylvania State College, State College, Pa. (Associate Member to Member)

WILSON, ROBERT W. — Assistant research professor of agricultural engineering, North Carolina State College, Raleigh, N. C. (Mail) 801 Runnymeade Rd. (Associate Member to Member)



GET BOTH–

from one competent source

Cleve-Weld can supply not only your rims, but also the circular, rolled and welded steel parts, such as welded gear blanks, for your tractors and implements. Perhaps you are making these parts in your own plant or buying them outside. Whichever the case, match our prices with your costs. The price differential may be decidedly favorable.

Like other Cleve-Weld products, gear blanks and other rings, hoops, and bands are mass-produced on our own special equipment by engineers specializing in rolling, forming and welding carbon and alloy steels to various shapes. Any production man will know that the savings resulting from such specialization are worthwhile. Take advantage of our ability to save money for our customers. Send blueprints on your volume requirements for rims and circular parts, and ask us to quote.

THE CLEVELAND WELDING COMPANY
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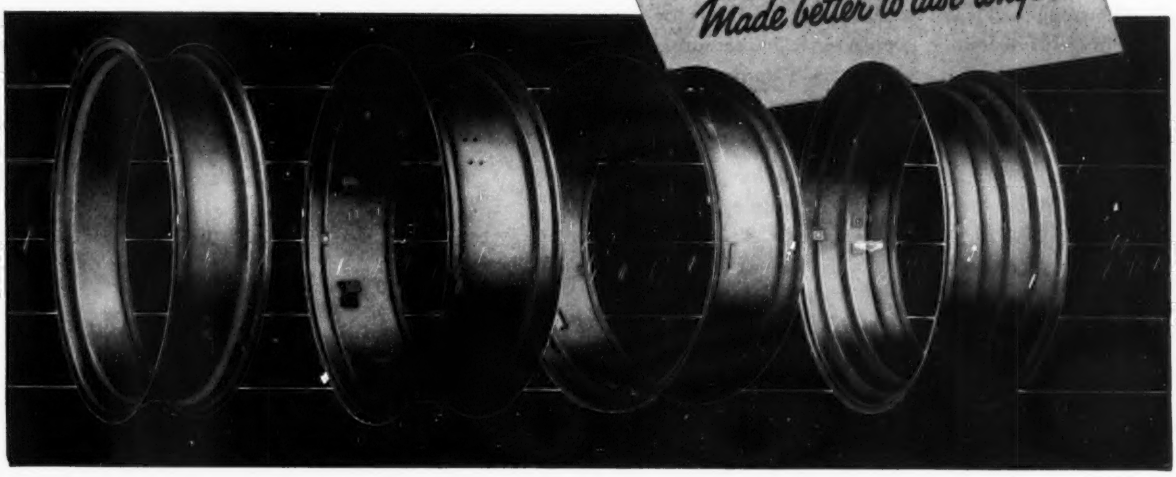
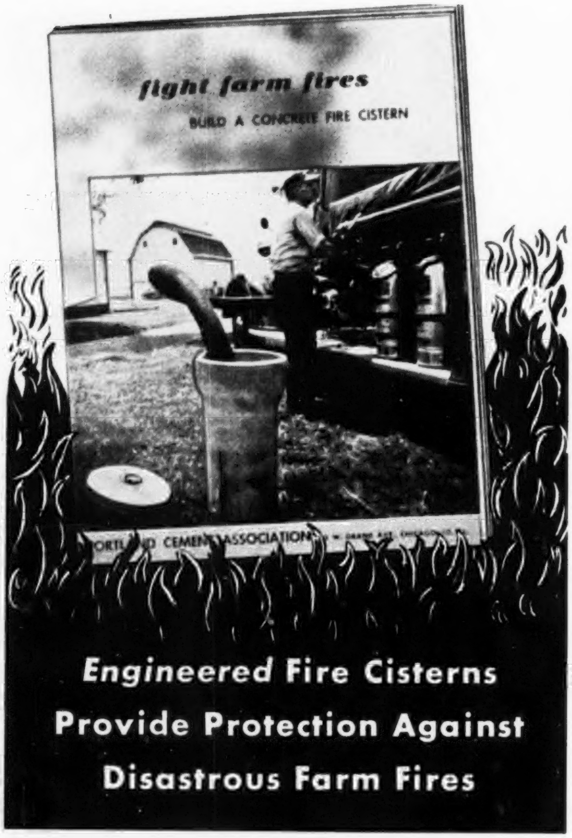
a subsidiary of
AMERICAN MACHINE & FOUNDRY COMPANY

CLEVE-WELD RIMS
Made better to last longer





Every 24 hours fire strikes 100 farm families, leaves 9 persons dead and destroys $250,000 worth of farm property.

Agricultural engineers can help reduce this heavy loss by (1) encouraging the use of fire-safe concrete construction and (2) designing concrete fire cisterns that provide an abundant supply of water for fighting fires.

An underground concrete fire cistern will store water economically and efficiently. Through cooperation with rural builders or groups of farmers it is possible to make multiple use of the same set of forms. This simplifies construction, saves money and provides each farmer with priceless fire protection.

Designing underground cisterns for protection against fires is another example of the agricultural engineer's service to America's farmers. For helpful design data write for the booklet illustrated above. It is free but is distributed only in the United States and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. A2-1, 33 W. Grand Ave., Chicago 10, Ill.

A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

NEWS FROM ADVERTISERS

New Products and Literature Announced by
AGRICULTURAL ENGINEERING Advertisers

New Maurey V-Drive Catalog

Maurey Manufacturing Corp., Chicago 16, Ill., is offering users of V drives a new 44-page catalog as a useful and convenient source of buying information on V drives and drive parts and accessories in the range of fractional to 10 hp. This illustrated book presents complete, easy-to-read descriptions, listings and price data on the Maurey line of bushed-type and fixed-bore-type cast-iron and pressed-steel V pulleys, Mor-Grip V belts, refrigeration fans and fan pulleys, and V-drive accessories. Of particular interest are the pages devoted to the interchangeable bushings and the new flexible couplings with a shock-absorbing rubber bond specially developed by Goodyear engineers. An engineering data section provides general information helpful to every drive user in selecting the proper drive for his particular requirements. The new Maurey V-drive catalog is available without charge. Requests should be made on Company letterheads and should specify the position of the individual requesting a free copy. All requests should be addressed to: Catalog Department, Maurey Mfg. Corp., 2915 S. Wabash Ave., Chicago 16, Illinois.

Link-Belt Directory

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., offers a 48-page illustrated directory of its products and organization. A condensed summary of the various types of products it manufactures is followed by information on the industries it serves, its research and engineering, manufacturing plants, offices and personnel, distributors, and export sales representatives. Ask for Book 2453.

Manure Spreader Catalog

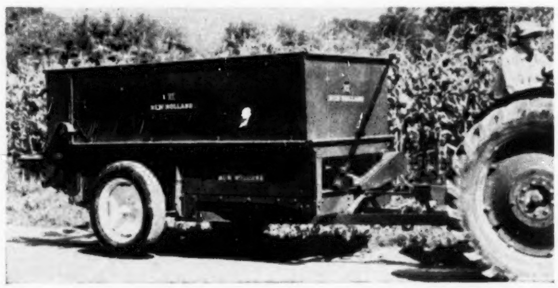
Massey-Harris Co., Racine, Wis., have available for distribution on request copies of a new 8-page spreader catalog which describes and illustrates the features of the Company's standard No. 11 and new No. 15 spreaders. The first half of the publication deals with the standard 70-bushel No. 11 spreader and such features as the machine's widespread distributor, convenient operating levers and large capacity beaters. The second half introduces the new 90-bushel No. 15 spreader with wide upper beater and auger-type distributor.

Dual-Purpose Spreader Box

New Holland Machine Company, New Holland, Pa., now has in limited production a manure spreader that doubles as a self-unloading forage box to give the farmer another double-duty machine. The Model 300 is a power-take-off machine with steel sides and a wood bed. By the addition of extension sides to the spreader it becomes a forage box capable of carrying 2½ to 3 tons of chopped material. As a manure spreader it has a capacity of up to 130 bu.

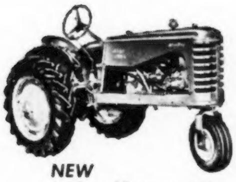
A combination of any one of the 4 apron speeds and the beater—widespread action controlled by the power take-off gives the operator even distribution within limits of 12 to 20 ft. A single feed lever at the front of the machine gives the operator complete control within his reach of the widespread, beaters and apron. The apron can be operated at the same time as beaters and widespread or independently. This allows a farmer to empty a load of manure with beaters idle, preventing throwback on the operator.

At the back a tail gate is hinged at top and middle to provide an easy way to close the rear for containing chopped material being blown into the box. This hinged gate is lifted and swung over the beaters when discharging the load. Action of the beaters unloads the material uniformly and without any manual labor. The entire widespread can be quickly removed when using the machine as a forage box. Each paddle is also removable for easy replacement.

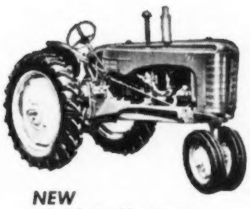


New Holland spreader converted to self-unloading forage box

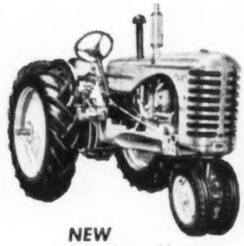
(Continued on page 122)



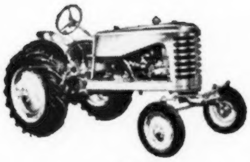
NEW
2 plow Mustang. 140 cubic inch L-head engine. 4 forward speeds. Depth-o-matic 2-way, Hydraulic System.



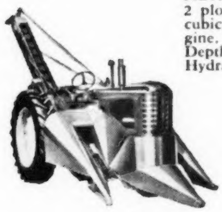
NEW
2-3 plow 33 tractor with 201 cubic inch removable sleeve overhead valve engine. 5 forward speeds. Live P.T.O. Depth-o-matic Hydraulic System.



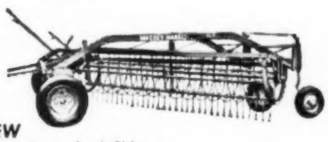
NEW
3-4 plow 44 tractor with 260 cubic inch removable sleeve, overhead valve engine. 5 forward speeds. Live P.T.O. Depth-o-matic Hydraulic System.



NEW
2 plow Colt with 124 cubic inch L-head engine. 4 forward speeds. Depth-o-matic 2-way Hydraulic System.



NEW
2-row Mounted Corn Picker with balanced design, full visibility. Easy to put on and take off — one man, one hour.



NEW
4 bar, low wheel Side Delivery Rake. Big capacity, cleaner raking. Better balance through two rear caster wheels.

What's new from

MASSEY-HARRIS

It's a never-ending policy at Massey-Harris . . . a constant goal to outperform the field in every tractor, combine and implement. To you it means a continuous parade of new and improved products that cut the number of jobs in an operation, speed up field work and do better work at less cost.

This policy extends beyond power in tractors . . . capacity in combines . . . or adaptability in tools. It's an overall program of better farming equipment that does more to help you make a profit.

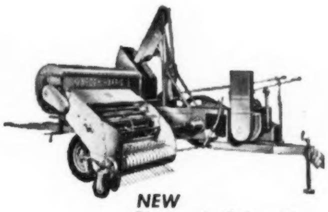
Along with power, it means greater efficiency in engines, transmissions, clutches and controls of tractors . . . in the balanced design of full-width cylinders, strawracks and shoes of combines . . . in the adjustments, strength, and work output of implements. It means greater efficiency in all of the things that result in a better job in less time, at less cost on your own farm.

Your Massey-Harris Dealer will be glad to give you complete information on the Massey-Harris way of more profitable farming.

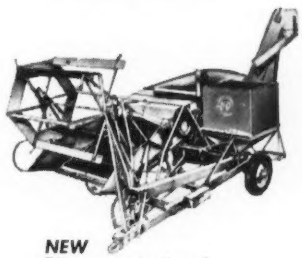
Make it a Massey-Harris

Parts and Service through more than 2500 Authorized Dealers

NEW
No. 15 Manure Spreader. 90 bushel capacity. Built-in jack. Low sides, easier loading. For smaller herds and acreages the 70-bushel No. 11 or the 47-bushel No. 10T are ideal.



NEW
Big capacity Baler with simplified construction. Forms bales 14 x 18 x 37. Enclosed gear drives. Ties under compression.



NEW
Bigger capacity 6- and 7-foot Clipper 50 Combines. Longer strawrack and shoe, more efficient cylinder and beaters, adjustable reel, slow speed cutter-bar.

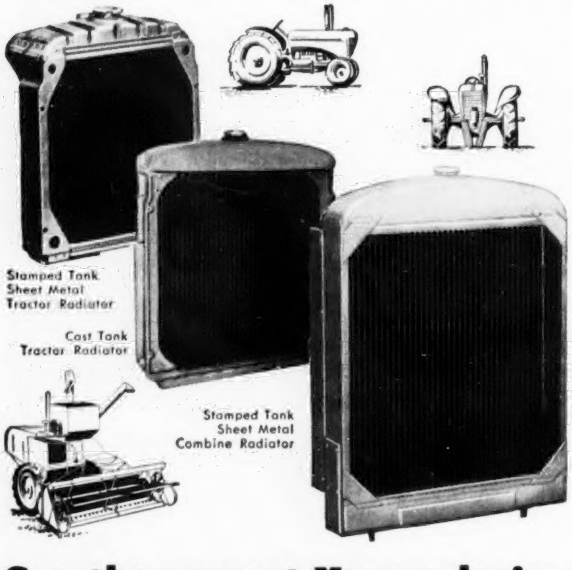
NEW
70 Self-Propelled — value priced. 24 forward speeds, mechanical speed selector, 24 inch cylinder, electric table lift, patented vertical feeder, 45-bushel tank plus Massey-Harris Balanced Separation that does so much to save grain. 12-, 10- and 8½-foot models.

NEW
80 Self-Propelled — 32-inch cylinder, 32-inch full-width straw walkers and shoe. Hydraulic speed selector and live axle drive. Hydraulic table lift. Balanced Separation. New operating comfort. 14-, 12- and 10-foot cuts. 12- and 10-foot Rice Models on tracks or tires.

NEW
90 Self-Propelled — 37-inch cylinder, 37-inch full-width straw walkers and shoe. Hydraulic speed selector and live axle drive. Hydraulic table lift. Balanced Separation. New operating ease. 16-, 14- and 12-foot cuts. 14- and 12-foot Rice Models on tracks or tires.

Farm equipment manufacturers:

ARE YOU GETTING THE MOST FOR YOUR RADIATOR DOLLAR?



See the newest Young design features before you decide

There *is* something new in tractor and implement radiators! Let us show you how Young engineering, modern production machines, and careful attention to details in manufacturing combine to produce radiators that are simpler in design, less costly to make, and more efficient in performance. This, we believe, explains the fact that more and more manufacturers of farm and industrial tractors and self-propelled farm implements are turning to Young for their heat transfer requirements.

Be sure *you* are getting the best possible radiator value. Send us your requirements, let us show you our product, then compare our proposal. Incidentally, we can offer similar economies, including *complete* "packaged cooling," in passenger car, truck, bus, aircraft and stationary engine applications.

1927 • 1952 25 YEARS OF PROGRESS IN HEAT TRANSFER ENGINEERING

YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY

Dept. 293-B • RACINE, WISCONSIN
Factories at Racine, Wisconsin and Mattoon, Illinois

NEWS FROM ADVERTISERS

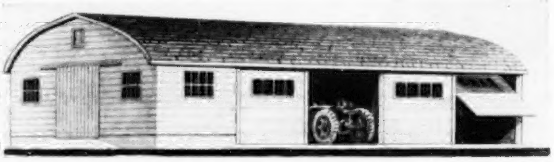
(Continued from page 120)

Small Parts Bulletin

The Torrington Co., Torrington, Conn., has made available on request a catalog listing the small precision metal parts made by its Specialties Division. Some of the many parts described and illustrated are special pins and pivots; screw driver blades; all types of rotary swaged rods, wires and tubing in practically all kinds of metals; mandrels for grinding wheels, abrasive points and polishing wheels; perforating punches in straight carbon or alloy steels; tapered or pointed wires and rods. Also listed are the Torrington district offices and special representatives.

Tied Arch for Farm Construction

Rilco Laminated Products, Inc., St. Paul, Minn., have developed a new tied arch for farm construction, called the Rilco Type 75. One indicated advantage is that any type of roof covering can be used. Because the tied arch is formed in two segments, with a straight section on either side of the ridge connection, there is no flat section in the center as in regular arch construction. Another advantage is the lightness in weight of the arches. No special skill or equipment is required to assemble and erect this arch. Spacing is 2 ft o.c., which eliminates the need for roof and ceiling joists. Nominal 1-in sheathing is nailed directly to the arches, and ceiling material can be nailed to the ties.



Rilco tied arch on machine shed

Like other Rilco products, the Type 75 tied arch is laminated of selected finish grade, kiln-dried West Coast Douglas Fir. The resorcinol glue is waterproof. Ties and vertical hangers are cut to size from solid dimension lumber. All splices are made with Teco splitring connectors. Arches and ties are cut and drilled by Rilco, then shipped unassembled with the necessary connection hardware This new tied arch is expected to be popular for use in barns, machine sheds, hog and poultry houses. Spans range from 24 to 40 ft with center heights ranging from 4 ft 2½ in to 8 ft. 9½ in.

Heavy-Duty Farm Tractor

The Oliver Corporation, Chicago, Ill., recently announced a new 4 to 5-plow heavy-duty farm tractor. Designated as Model 99, it is available with a 6-cylinder engine, either diesel or gasoline, and is styled similarly to Oliver's streamlined 66, 77 and 88 models.

A number of features of Oliver's 66—77—88 tractor series have been incorporated in the new 99 tractor. Many engine parts are identical to those used elsewhere in the Oliver tractor fleet. simplifying the repair parts problem. The new 99 engine features overhead valves, by-pass thermostat, metered lubrication and a heavy-duty automotive type clutch. Disk-type steering brakes and recirculating ball steering reduces operator steering effort to a minimum. The entire hood can be removed to give full access to engine and radiator.

The 99 diesel is a true diesel. It starts easily on diesel fuel at normal temperature, and is equipped with an ether injection unit for quick starts in cold weather. Both the gasoline and diesel-powered 99's are available in standard and rice field models.

Oliver 99 diesel 4-5-plow tractor

(Continued on page 124)

Produce them better, faster, more economically by high-strength bolting!

Just as the construction industry has saved money, you can too . . . by switching from your present fasteners to high-strength RB&W bolts on joints of plow and tractor frames.

These joints are essentially structural joints, subject to widely fluctuating dynamic loading. Such joints hold tight longer when bolted with high-strength bolts, as proved by field tests in highly-stressed railway structures.

Thanks to the greater holding power of high-strength bolts, you save many ways. You save production costs—although high-strength bolts cost more, you use fewer bolts and of smaller diameter. You save assembly time, for fewer bolts mean faster assembly. Above all, you give customers what they want—stronger, more rugged products that require less maintenance.

Ideally suited for highly-stressed structural joints are RB&W quenched and tempered steel bolts to A.S.T.M. Specification A-325 . . . heat-treated to assure the best combination of tensile strength, toughness and ductility to meet heavy load conditions.

Address RB&W at Port Chester for a report on "The Effect of Various Fasteners on the Fatigue Strength of a Structural Joint."

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Pittsburgh, Detroit, Chicago, Dallas, San Francisco. Sales agents at: Portland, Seattle. Distributors from coast to coast.

RB&W THE COMPLETE QUALITY LINE

108 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

McGRAW-HILL BOOKS

FARM MACHINERY AND EQUIPMENT

By HARRIS PEARSON SMITH, Chief, Division of Agricultural Engineering, Texas Agricultural Experiment Station. *McGraw-Hill Publications in Agricultural Engineering.* Third Edition, 533 pages, $6.00.

Presents a treatise on farm machinery covering the most important types of machines used in general farming – their design, construction, operation, and efficiency. An effort is made to cover the latest types of machines developed for the farm and those machines that have proved to be economical in their use and instrumental in reducing cost of production.

FARM GAS ENGINES AND TRACTORS

New 3rd Edition

By FRED R. JONES, Agricultural and Mechanical College of Texas, *McGraw-Hill Publications in Agricultural Engineering.* 489 pages, $6.00.

Considers the farm power requirements of agriculture and the effect of power on agricultural production. Deals entirely with the construction, design, and operation of the internal combustion engine as a stationary farm power unit, and the tractor as an automotive farm power unit. Will give the student a thorough understanding of engines and tractor and the factors involved in their selection and use.

FARM ENGINES AND TRACTORS

By H. E. GULVIN, University of Rhode Island. *McGraw-Hill Publications in Agricultural Engineering.* Ready for fall classes.

Easily understandable in presentation, including simplified drawings, this text provides much technical information for student, farmer, 4-H member. It covers parts of engines; general terms; operations principles of 2- and 4-stroke diesel and otto engines; carburetion, lubrication, ignition; tractor history, selection, maintenance, tuneup, and operation; special sections on transmission of power by tractor, truck, and car; and complete discussions of engine performance.

Send for copies on approval

McGraw-Hill Book Company, Inc.

330 West 42nd Street New York 36, N. Y.

NEWS FROM ADVERTISERS

(Continued from page 122)

Pick-up, Twine-tie Baler

Dearborn Motors Corp., Birmingham, Mich., has added to its line a new one-man hay baler, which will produce three to eight bales per minute and has a capacity of up to 10 tons of hay per hour.

Bales measure 16 by 18 in, with either 36 or 42-in lengths. Bale weight can be adjusted between 50 and 100 lb. A 25-hp engine provides power for baling under varied conditions. With this engine, stacked hay can be baled as efficiently as windrowed hay. The plunger compresses hay without missing a stroke during the tying operation. The knot is tied while the bale is under compression and the twine is tension-free. The result is a firm knot plus a saving in twine. A guide wheel on the outer side of the 59-stroke floating pickup follows ground contours closely, leaving little hay on the ground. After the hay has been picked up, an even-feeding auger and sweep fork move it into the baling chamber.

An automatic bale tension bar makes possible well-packed, tightly tied, square bales. Other features include axle balanced weight, adjustable drawbar, built-in drawbar jack, tractor-seat power control, bale counter and starting equipment.

Dearborn pick-up twine-tie baler

Moisture Content Determinations

(Continued from page 110)

5 F. W. Dunmore: An Electric Hygrometer and Its Application to Radio Meteorology. J. Res. Nat. Bur. Std. (Res. Paper 1102) 20 : 723-744, 1938.

6 S. M. Henderson: A Basic Concept of Equilibrium Moisture Content. AGRICULTURAL ENGINEERING 33 : 29-32. 1952.

7 John Mitchell, Jr., Karl Fischer: Reagent Titration. Anal. Chem. 25 : 1069-1075. 1951.

8 S. F. Brockington, H. C. Dorin, and H. K. Howerton: Hygroscopic Equilibria of Whole Kernel Corn. Cereal Chem. 26 : 166-173, 1949.

9 Methods for the Determination of Water. Anal. Chem. 25 : 1058+. 1951. (A symposium covering a number of methods.)

10 W. R. Fetzer: Determination of Moisture by Distillation. Anal. Chem. 25 : 1062-1075. 1951.

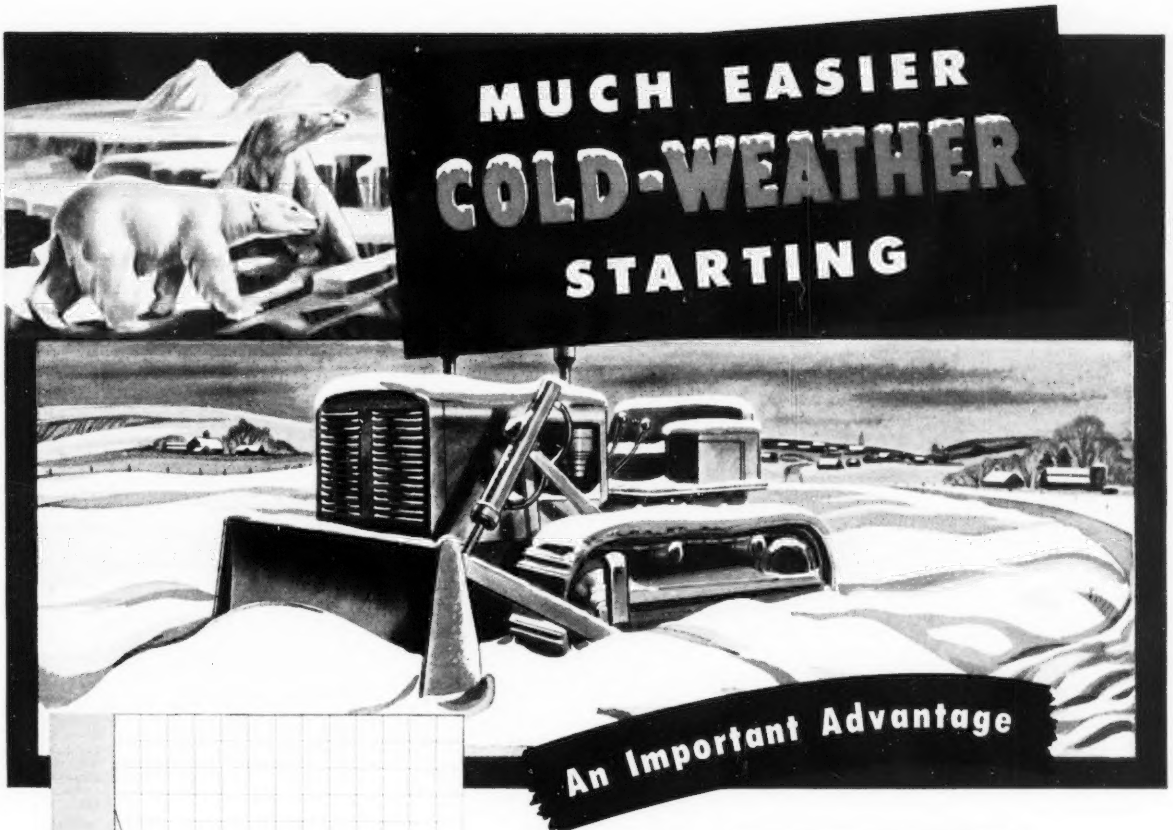
Limits of Engineering Manpower

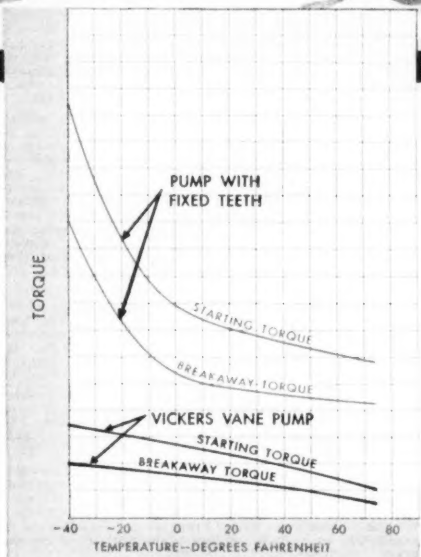
(Continued from page 87)

of about 22,000, 2 per cent of our young manpower, or less than 12 per cent of the maximum intellectual potential. In comparison, estimates of current demand for engineering graduates run upward from 30,000 per year, and estimates of the current backlog shortage are around 50,000.

Further attrition following graduation reduces the percentage of our male population identifiable as engineers to a current figure slightly over one-half of one per cent, and an estimated maximum of about 0.55 per cent.

The dean's figures present an unlovely picture of the engineering profession, of all groups, carrying its manpower in a sieve, dribbling it out in a steady stream along the way, and delivering to the engineering service of mankind a half measure of its potential. It is indeed time for engineers to look to their efficiency in utilizing their own manpower as well as that of other workers.





Curves based upon comparative tests of a Vickers Vane Type Pump and one with fixed teeth of equal capacity. Oil used complied with Army Spec. 2-79-B.

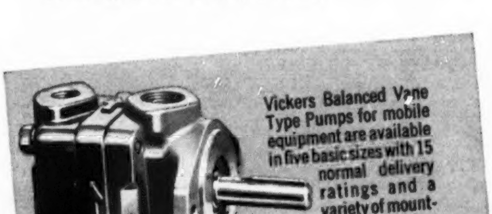
With VICKERS

BALANCED VANE TYPE PUMPS

Cold weather imposes a double handicap in starting. All engine parts tend to be stiffer, and the power of the starting battery is greatly diminished. In vehicles furnished with power hydraulic equipment, the starting load may be seriously increased when a pump with fixed teeth or lobes is directly connected to the engine.

Vickers Balanced Vane Type Pumps do not have this effect. At rest and at normal starting speeds, the sliding vanes are retracted . . . only after the engine fires do the vanes extend and pumping begins. The result is that Vickers Vane Type Pumps make cold weather starts much easier.

For further information, get in touch with the nearest Vickers office listed below.



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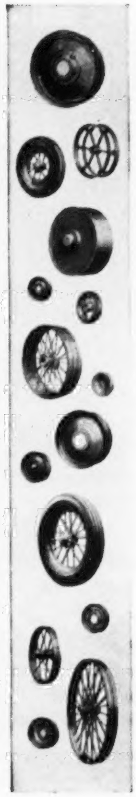
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



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There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

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ELECTRIC WHEEL CO.

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KOHLER ENGINES

Power for garden tractors, mowers, pumps, sprayers, snow removal equipment, elevators and hoists, portable saws, concrete mixers, compressors, grinders, industrial and lift trucks, and a wide range of tools and equipment for industry construction, farm and home.

Engineered and built to the quality standards that have won acceptance for Kohler Electric Plants the world over.

Kohler Co., Kohler, Wisconsin, Established 1873

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PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — 1952 — OCTOBER — O-767-583, 767-584, 782-589, 785-591, 774-595. NOVEMBER—O-824-596. DECEMBER—O-797-597, 875-598, 876-599. 1953—JANUARY—O-869-600, 891-602, 894-603, 892-604.

POSITIONS WANTED—1952—SEPTEMBER—W-735-133, 739-134. OCTOBER—W-769-137. NOVEMBER—W-793-141, 791-142, 823-144, 810-145. DECEMBER—W-843-146, 814-147, 832-148, 849-149, 866-150, 860-151. 1953—JANUARY—W-827-152, 872-153, 884-154, 886-156, 896-157, 899-158.

NEW POSITIONS OPEN

RESEARCH ASSISTANT in rural electrification for grant-supported work in electrical aspects of rural applications, in agricultural engineering department of a midwestern land grant university. BS deg in electrical engineering and farm background, or BS deg in agricultural engineering with special training in electrical engineering. MS deg desirable. Some practical electrical experience, plus leadership, initiative, ability to assume responsibility, to cooperate, to get along with others and work effectively as one of a team. Opportunities for advancement same as for others in the department. Opening to be filled by April or sooner. Age 22-28. Salary $3800-4500. O-907-605

AGRICULTURAL ENGINEER (assistant or associate professor) for teaching service and professional courses in a land grant university in the Northeast. Summers devoted to experiment station research. BS or MS deg in agricultural engineering, or equivalent. Farm background and teaching, research, or commercial experience. Skill in crafts related to agricultural engineering. Usual personal qualifications for college and experiment station work. Normal opportunity for advancement. Opening effective about February 1. Salary $4500 approximate. O-911-606

RESEARCH AGRICULTURAL ENGINEER for full-time work on mechanized weed control, planting, and fertilization of cotton, in close coordination with work of agronomists, in the land grant college and agricultural experiment station of a southeastern state. BS or MS deg in agricultural engineering with grade average of "B" or better. Farm background. Some research experience desirable. Need not be familiar with cotton culture. Usual personal qualifications plus genuine interest in research and in the design and development of farm machinery, together with initiative, drive, imagination, and ability to think clearly. Good opportunity for advancement. Some graduate credit available. Excellent shop facilities. Drafting, mechanical construction and statistical service furnished. Excellent retirement system. One month vacation. Age 20-30. Salary open. O-7-501

EXTENSION AGRICULTURAL ENGINEER with a rapidly growing New England University. Prefer farm background, some teaching or extension experience, and MS deg. BS deg. in agricultural engineering may be acceptable if other qualifications are good. Age 25-30. Good retirement system provided. Opportunity for advanced study. Rank and salary will depend upon qualifications. O-6-502

PRODUCT PLANNING SUPERVISOR for large established industrial organization, Michigan area. Engineering degree. Farm or farm machinery background. Will be responsible for establishing long range product planning and programming changes into current models. Salary $7500-9000 per year. O-10-503

RESEARCH AGRICULTURAL ENGINEER for work in farm structures in a southern state university. BS deg in agricultural engineering required, MS deg desirable. Farm background and some research experience desirable. Ability to get along with associates. Opportunity for advancement very good. Wide open field. Progress up to individual with an urge for original work. Age 22-35. Salary $3400-4000 on 12 mo basis, with 30-day vacation. O-11-504

NEW POSITIONS WANTED

DEVELOPMENT, research, extension, or writing, in farm structures, rural electric, product processing or irrigation fields with industry or public service, any location. BS deg in civil engineering 1935. BS deg in agricultural engineering, 1936. MS deg in agricultural engineering, 1939. Research and extension with a land grant college 8 yr. Development and research on product processing and irrigation with TVA, 7 yr. Operation of home farm one year. Married. Age 38. No disability. Available on 30-day notice. Salary open. O-889-159

DESIGN, development, research, sales, service, or writing in farm structures or rural electric field, with industry, in Midwest or West. BS deg in agricultural engineering, 1952, South Dakota State College. Farm background. Retail sales clerk one year. War service 2 yr noncommissioned, as engineer supply clerk. Part time work with agricultural engineering department while in college. Currently engaged in design and drafting with consulting engineer in REA field. Single. Age 24. No disability. Available on 30-day notice. Salary open. W-893-160

SALES, service, writing, or management in power and machinery or product processing with federal agency, manufacturer, processor, or consultant. West Coast location. BS deg in mechanical engineering, agricultural engineering option, 1950, University of California. Farm background. Pump testing, 3 mo. Sprayer and pump design, 2 yr. War noncommissioned service 4 yr as Signal Corps radio operator. Married. Age 31. No disability. Available now. Salary $4200. W-895-161

(Continued on page 128)

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

GENERAL ELECTRIC Farm News

Ask for G-E Motors and Control on all Electrified Farm Equipment you buy!

MORE POWER TO THE AMERICAN FARMER through more electricity on the farm

STOCK WATERERS SAVE WORK FOR FARMER

FARM WIFE SOLVES GARBAGE DISPOSAL PROBLEM

Finds source of soil-enriching mulch for garden

Mrs. Spencer using her mulch-producing garbage disposal unit, located on back porch.

Mrs. C. B. Spencer, Route 1, Downingtown, Pa. has been using a garbage disposal unit which turns her kitchen garbage into a fluid mulch. Mrs. Spencer is well satisfied with her unit. She says, "I've used it every day for the last two years. It takes care of my garbage and makes it odorless and ready to use as a fertilizing mulch. I use the mulch in my garden around strawberries, tomatoes, flowers, and shrubbery."

Removes objectional odor

This machine quickly reduces garbage to an odorless mulch. No need to store any garbage for collection or to bury garbage and then worry that animals will dig it up. The fluid mulch returns organic matter to the soil and helps the soil to retain moisture.

Has other uses

The unit will produce mulches from leaves, manure, cuttings, or even newspaper. Sharp cutting edges transform materials into a fluid mulch. The machine does in minutes what a compost heap takes months to do.

The unit is powered with a dependable G-E motor. For more information check "Garbage Disposal" on the coupon to the right.

They work automatically, won't freeze in winter, help boost meat production by adequate watering

One of the electrically heated automatic stock waterers in use on Oryne Kersten's farm. It warms the water to assure plentiful supply for his animals even in coldest Iowa weather.

"Thanks to my automatic stock waterers," says Mr. Oryne Kersten of Dysart, Iowa, "I can water 50 head of cattle and 100 head of hogs without lifting a finger. What's more, I don't have to chip ice in the winter." Mr. Kersten raises registered Hereford beef cattle and spotted Poland-China hogs.

Completely automatic

Mr. Kersten saves time and labor by eliminating tedious watering chores. Stock waterers have precision-made float valves which insure that troughs will be full at all times.

Won't freeze in winter

There's no chipping ice out of watering troughs because an electric heating unit keeps them free of ice even in subzero weather. Just set the thermostat in the fall and forget about it. Water is kept at temperatures at which animals will drink more readily. Remember that water helps to make beef and pork.

These waterers are protected against corrosion, and are insulated to minimize heat loss. A G-E CALROD* heating unit provides the heat and a thermostat turns it on and off for economical operation. Animals can't reach the heating unit. For more information check "Stock Waterers" on the coupon.

*Registered Trademark of General Electric Co.

ONE MAN TAKES CARE OF 6000 BREEDER CHICKENS

Mechanical feeders save work for New Jersey Leghorn breeder

"I've been using two automatic feeders for two years," says Mr. Gus Stern, owner-manager of Stern Bros. Hatchery, South Vineland, N. J. "One man now easily takes care of 6000 Leghorn breeders. He could take care of 12,000 if necessary. Using the old hand feed method, a man could take care of only 3000 birds and work harder doing it."

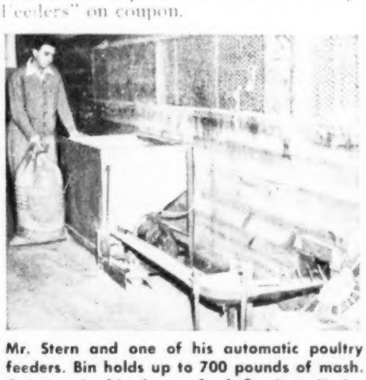
Cuts feed handling

Each feeder holds up to 700 pounds of mash, so one filling lasts for a long time. Since both feeders are in one room, where feed is also stored, all filling and feeding is done in one place.

Continuous chain carries feed from bin through a V-shaped feeding trough. Uneaten feed is returned and mixed with new feed to maintain freshness.

Troughs do not clog or overflow. Also, because there is no bridging of the chain over the mash, all mash is moved through the trough. Feeders are easy to install, easy to maintain, easy to clean.

These automatic poultry feeders are powered by G-E gear motors. For more information please check "Poultry Feeders" on coupon.



Mr. Stern and one of his automatic poultry feeders. Bin holds up to 700 pounds of mash. Agitator in bin keeps feed flowing. Notice wire guards on trough and guard on corner.

General Electric Company
Section 671-25D, Schenectady 5, N. Y.

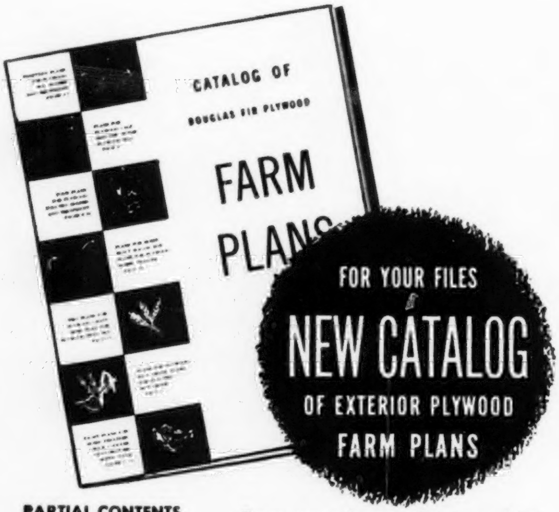
I would like additional information on the following equipment.

- [ ] Stock Waterers
- [ ] Garbage Disposal
- [ ] Poultry Feeder
- [ ] How To Choose Your Motor

NAME ______

ADDRESS ______

CITY ______ STATE ______



PARTIAL CONTENTS
- HOG HOUSES
- FARROWING HOUSES
- HOG WALLOWS
- CALF SHELTERS
- FREEZERS
- BROODER HOUSES
- GRAIN BINS
- FEED BINS
- NUT DRIERS
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There's a Rain Bird Sprinkler to fit every irrigation problem —19 in all, ranging in size from 1½ G.P.M. at 3 pounds pressure to 610 G.P.M. at 120 pounds pressure.

If yours is a special irrigation problem, consult our research department now.

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to ASAE members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

Personnel Service Bulletin

(Continued from page 126)

TEACHING, research, design, development, or management, in power and machinery or soil and water field (major interest in irrigation) with industry or public service in South or Southwest. BS deg, 1939, Southwestern Institute of Technology. BS deg in agricultural engineering, 1946, Oklahoma A. & M. College. MS deg in agricultural engineering, 1947, Texas A. & M. College. IE (awaiting approval of thesis), Utah State Agricultural College. High school science instructor 2½ yr. War commissioned service in Naval Air Corps 4 yr (photographic mapping 2 yr; design of aircraft camera installations 2 yr). Professor and head of college agricultural engineering department 2 yr. Assistant director for Brazil, American International Association, one year. Various periods of combined graduate study and teaching or other engineering work. Currently consultant on irrigation project. Speaking knowledge of Portugese and Spanish. Registered professional engineer. Federal Civil Service engineering ratings, GS-13. Married. Age 35. No disability. Available April 1. Salary open. W-915-162

RESEARCH, service, or writing applied to marketing equipment or product processing with industry, preferably in Midwest, Northeast, or Canada. BS deg in rural economics, 1948, Ohio State University. Marketing research on facilities and processing USDA, 1948-51. Statistical work and dairy plant experience on federal milk marketing order 75, 1951 to present. Pregraduation experience 7 yr as foreman, Republic Steel Corp., in production and metallurgy. War service in Army Air Corps 3 yr. Married. Age 36. No disability. Available now. Salary $5500-6000. W-2-1

DEVELOPMENT, extension, sales, or service in rural electrification with federal agency or manufacturer, in Midwest. BS deg in agricultural engineering, 1950, Purdue University. Farm background. Assistant in concrete laboratory 1½ yr while in school. Power use advisor, with REA coop, present position, 2½ yr. Work is in rural service engineering, including installations and inspection. War service in Navy 32 mo. Married. Age 27. No disability. Available now. Salary $5000. W-16-2

DESIGN, development, research, teaching, or writing in farm structures field with industry or public service. Any location. BS deg in agricultural engineering expected in June. Experience 2 yr. with Ford Instrument Co. adjusting and precision assembly of naval fire control instruments. Flight navigator, American Overseas Airline 6 yr. Dairy farm experience 3 mo. Real estate 3 yr. Sales and service of private and commercial insurance accounts 3 yr. War service in Navy pilot training program 9 mo. Married. Age 30. No disability. Available in June. Salary open. W-4-3

DESIGN, development, research, or management in power and machinery, farm structures, rural electric, or product processing, in industry or public service, preferably in area between Mississippi River and Rocky Mountains. BS deg 1952, MS deg expected in May, 1953, in agricultural engineering, Kansas State College. Farming experience. Drafting work with agricultural engineering department at Kansas State College two summers. Graduate research assistant one year. War enlisted service in Army over one year. Married. Age 25. No disability. Available June 1. Salary open. W-13-4

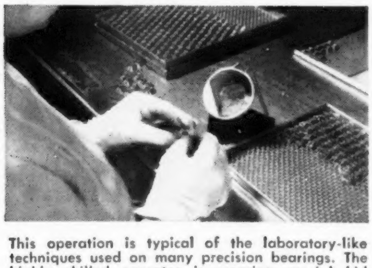
DEVELOPMENT, research, or extension in power and machinery, soil and water or product processing field with industry or public service in Pacific Coast or other mild climate area. BS deg, 1950, University of California. MS deg, 1952, Oregon State College. Farm background. Summer work as carpenter in general construction. Assistant to math professor 1 yr. Graduate research assistant 2 yr. Currently mechanical design engineer with Navy, and teaching basic engineering course. Single. Age 24. No disability. Available on reasonable notice. Salary open. W-21-5

EXTENSION, teaching, research, or writing in power and machinery or soil and water field, with industry or public service. Any location. BS deg in agriculture, major in agricultural engineering, 1950, University of Missouri. Farm background. Nearly 3 yr experience teaching general agriculture in veterans-on-farm training program. War enlisted service in Navy nearly 2 yr, with training and experience in radar. Married. Age 30. No disability. Available now. Salary open. W-19-6

DESIGN, development, research or extension in power and machinery or soil and water field with experiment station or federal agency, or with manufacturer. Anywhere except in eastern or northern states. AB deg in physical science, Culver-Stockton College, 1931. BS deg in agriculture, major in agricultural engineering, University of Missouri, 1937. Farm background. Operated terracing equipment one summer. Assistant county supervisor in Farm Security Administration one year. USDA Marketing Service, 1941-47, except for War Service in Navy, 3 yr. Teaching veterans-on-farm training classes since April, 1947, including layout of terraces, diversions, outlets and ponds on farms of students. Married. Age 45. No disability. Available on one month notice. Salary open. W-26-7

DESIGN, development, research, extension, teaching, sales, or service in power and machinery or soil and water field, with industry or public service in the Southwest or other high, dry climate. BS deg in agricultural engineering, 1938, Oklahoma A. & M. College. MS deg in agricultural engineering, 1951, Kansas State College. Agricultural engineering with SCS in Oklahoma, Kansas, New Mexico, and Arizona, 6 yr. Teaching agricultural engineering subjects at college level 6 yr. Research in addition to teaching past 4 yr. Married. Age 37. Myopia corrected by glasses. Available July 1. Salary $5400 min. W-27-8

Finer Than a Watchmaker's Masterpiece!



This operation is typical of the laboratory-like techniques used on many precision bearings. The highly skilled operator is wearing special kid gloves to avoid contaminating the ball bearing.

New Departure ball bearings are quickly available at your equipment dealer or bearing distributor—supplied from the industry's largest nation-wide network of warehouse stocks.

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

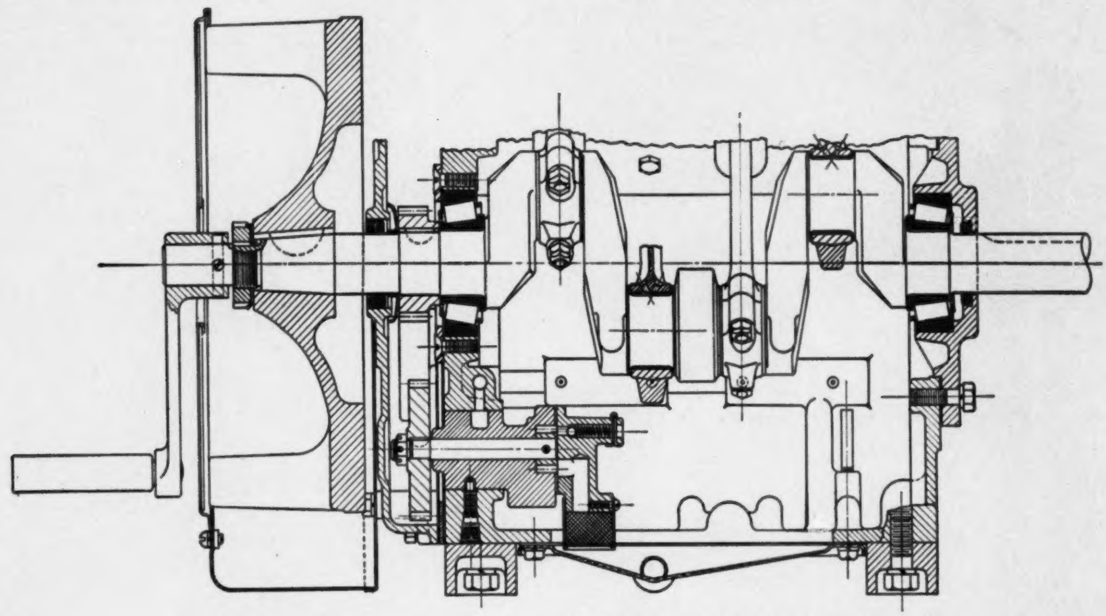
Also Makers of the Famous New Departure Coaster Brake

The finest products of the watchmaker's art do not reach the high level of precision attained by New Departure ball bearings. Manufacturing standards which insist on certain tolerances being held to millionths of an inch give these bearings the ability to provide the virtually friction-free support demanded by modern motors and machines.

In the farm field, New Departures are improving the performance and design of machines and implements, including new disc applications. Discs turn easily on New Departure ball bearings, providing much lighter draft and less maintenance. Better design at the factory . . . better work on the farm . . . because of New Departures.

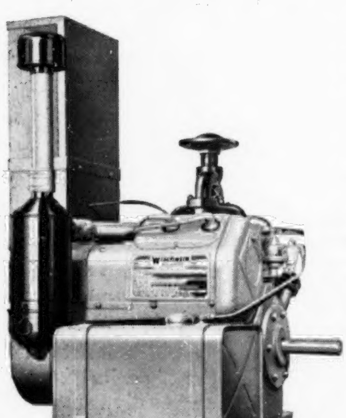
Research, engineering and production at New Departure are focused upon one major objective . . . making the *best* ball bearings for every kind of application. Keep your eye on the BALL to be sure of your BEARINGS!

EVERY NEW FARM TRACTOR HAS TIMKEN BEARINGS; MORE AND MORE IMPLEMENTS ARE USING THEM, TOO!



How Wisconsin engines are mounted on Timken bearings—the bearings that solve three of the agricultural engineer's biggest design problems.

How Wisconsin engineers solved three big design problems for 2,000,000 engines



By mounting the crankshafts of more than 2,000,000 Wisconsin engines on Timken® bearings, Wisconsin engineers solved these three big design problems at once:

1. Combination loads. Radial, thrust and combination loads are carried safely by the tapered construction of Timken bearings. Line contact between rollers and races permit greater load-carrying capacity. Crankshafts are held in positive alignment. Crankshaft wear is eliminated. Wear on other moving parts is reduced.

2. Ease of operation. The true rolling motion and incredibly smooth surface finish of Timken bearings permits moving parts to rotate freely by practically eliminating friction.

3. Dirt. Timken bearings hold shafts and housings concentric, making closures more effective in keeping dirt out and lubricant in. Maintenance time is cut, lubricant costs reduced.

More and more implement manufacturers are specifying Timken bearings because they assure farmer-customers of five extra advantages: longer implement life, easier operation, less chance of breakdown on the job, once-a-season lubrication and higher towing speeds.

For more information about Timken bearings, write now for your free copy of "Tapered Roller Bearing Practice In Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design . . .

Tapered Roller TIMKEN BEARING EQUIPPED

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION